

#### Joint Services Small Arms Systems Annual Symposium, Exhibition and Firing Demonstration

Albuquerque, New Mexico
"Meeting the Needs of Our Joint Ground Forcess in the Fight Against
Terrorism and Dveloping the Tools for Future Combat"

15-18 May 2006

Agenda

Tuesday, 16 May 2006

Keynote Address: Mr. Jim Sutton, PEO Ammunition

Panel: Joint Service Small Arms Synchronization Team (JSSAT)

- Chairman: COL Scott Crizer, USA
- COL Robert Radcliffe, USA, Army Member
- LtCol Richard Adams, USMC, Marine Corps Member
- Col Charles Beck, USAF, Air Force Member
- Mr. Jerald Gaskill, PMS NSW, APM Small Arms
- Commander Aaron Davenport, USCG, Coast Guard Member
- Mr. Kevin Swenson, JNLWD, Associate Member

#### **Session I:** Ammunition

- Chair: Mr. Ralph Mazeski, US Army ARDEC, Picatinny Arsenal, NJ
- 5.56mm Reduced Ricochet Limited Penetration (RRLP) Cartridge, Mr. Sung Y. Kim, NSWC Crane, IN
- Small Arms Ammunition Operational Temperature Stability Test and Evaluation, Mr. Charles T. Marsh, INSWC Crane, IN
- Development of Non-Toxic Ammunition in Scandinavia, Mr. Thomas Mauritzson, NAMMO
- · Advanced BALL POWDER® Propellant Technology for Enhanced Lethality and Green Ammunition, Mr. Steve Faintich, St. Marks Powder

#### Session II: JSSAP

- Joint Small Arms Capability Assessment Analytical Procedure, Mr. John Edwards, US Army ARDEC-JSSAP
- Lightweight Small Arms Technologies (LSAT) Program Update, Ms. Korene Spiegel, US Army ARDEC-JSSAP
- Design and Development of a 7.62mm Limited Range Coast Guard Round, Mr. Chad H. Sensenig, US Army ARDEC
- Anti-Materiel Sniper Rifle Congressional Program, Mr. Neil E. Lee, US Army ARDEC
- Plasma Transfer Arc Fabrication of Enhanced Performance Barrels, Mr. Kris C. Christou, MER Corporation

Wednesday, 17 May 2006

NDIA Armaments Division Status Overview, Mr. Dave Broden, Broden Resource Solutions, LLC

#### Panel: Soldier Weapons

- Mr. Richard Audette,, PM Soldier Weapons
- LTC Timothy Chyma, USA, PM Individual Weapons
- Mr. Pete Errante, PM Crew Served Weapons
- Mr. Michael Friedman, Chief, Logistics & Integration Division

The National Small Arms Center, Mr. Frank Puzycki, ARDEC-JSSAP

Session III: SOPMOD/SOF Weapons and Equipment

- SOPMOD Program Review, Mr. Gus Taylor, NSWC Crane, IN
- SOPMOD SOF Weapons Survey Report, Mr. Michael D. Iovino, The Wexford Group International

Luncheon: "The First Three Hundred Years of Small Arms (1326 – 1626)", Dr. Stephen C. Small, JSSAP/ARDEC

#### Session IV: International Programs

- Small Arms in NATO Transformation, Mr. Vernon E. Shisler, JSSAP/ARDEC
- NATO Small Arms Weapons Research & Technology Study, Mr. Per G. Arvidsson, FMV (Swedish Defence Materiel Administration)

#### **Session V:** Modeling and Simulation

- Gelatin Impact Modeling, Mr. Mark Minisi, US Army ARDEC
- · Virtual Wind Tunnel Experiments for Small Caliber Ammunition Aerodynamic Characterization, Dr. Paul Weinacht, US Army Research Laboratory
- Special Weapon Observation Remote Reconnaissance Direct Action System (SWORDS), Mr. Michael A. Zecca, US Army ARDEC
- Experimental Characterization and Modeling of 5.56mm Ammunition, Mr. Anthony W. Williams, US Army Research Laboratory
- Effects of Small Caliber Munitions through Intermediate Barriers, Mr. Chris Gandy, RDECOM-ARDEC

#### Session VI: Weapon-Related Ancillary Equipment

- UID Requirements, Mr. William E. Boyle, US Army ARDEC
- Suppressors, Evolving to an Integrated Unit, Ms. Sophia Tassy, US Army ARDEC
- M107 .50 Caliber Sound Suppressor, Mr. Joshua Semick, US Army ARDEC
- Analysis of Ruptured Case in M249 using ANSYS/LS-DYNA, Mr. Clinton Fischer, US Army ARDEC

#### Thursday, 18 May 2006

#### Session VII: Individual Weapons

- The Swedish AK 5 Rifle Upgrade Program, Mr. Per G. Arvidsson, FMV (Swedish Defence Materiel Administration)
- 5.56mm 30 Round Magazine Improvement Program, Mr. Adam L. Foltz, US Army ARDEC
- SOF Combat Assault Rifle, Mr. Troy L. Smith, NSWC Crane
- Sermon on the Mount!, Mr. Dick E. Swan, Atlantic Research Marketing Systems, Inc. (A.R.M.S.)

#### **Session VIII:** Crew Served Systems

- Advanced Lightweight Grenade Launcher (ALGL) Overview, Mr. Dennis Lambrecht, NSWC Crane
- ARDEC Rapid Design Projects for Field Support, Mr. Michael Narus, US Army ARDEC
- XM307 Integration, Mr. Robert Cavoretto, ACSW, GDATP



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"Meeting the Needs of Our Joint Ground Forces in the Fight Against Terrorism and Developing the Tools for Future Combat"



### PROGRAM AGENDA

### Program Agenda

Monday, May 15, 2006

9:00 AM - 4:00 PM Registration and Exhibits Set-Up

5:30 PM - 7:00 PM Reception in Exhibit Hall

#### Tuesday, May 16, 2006

7:00 AM Registration & Continental Breakfast

7:55 AM Welcome and Administrative Announcements

Mr. Sam Campagna, Director, Operations, NDIA

Mr. Brian Berger, Chairman, Small Arms Committee; Vice President, SNC Technologies

Corporation

8:10 AM Welcome Address

Ms. Joyce Pullen, Office of Senator Pete Domenici

8:30 AM Keynote Address

Mr. Jim Sutton, PEO Ammunition

9:00 AM PM Maneuver Ammunition Systems Panel

Chair:

COL Mark Rider, USA, PM Maneuver Ammunition Systems

Panel:

Mr. William Sanville, Deputy PM Maneuver Ammunition Systems

LTC Matthew Butler, USA, PM Medium and Small Caliber

10:00 AM Break in Exhibit Hall

10:30 AM Joint Service Small Arms Synchronization Team (JSSAST) - Panel

Chair:

COL Scott Crizer, USA, Chairman JSSAST

Panel:

COL Robert Radcliffe, USA, Army Member

LtCol Richard Adams, USMC, Marine Corps Member

Col Charles Beck, USAF, Air Force Member CAPT Richard Ruehlin, USN, Navy Member

CAPT (S) Aaron Rappaport, USCG Coast Guard Member

COL Kevin Noonan, USA, SOCOM Member

Mr. Richard Audette, PM Soldier Weapons Associate Member

Mr. Kevin Swenson, JNLWD Associate Member

12:00 PM - 1:30 PM Luncheon - Small Arms Section Awards, 2005

Chinn Award

Recipient: Mr. Dick Swan

Presented By: Mr. Angelo Mancini

Hathcock Award

Recipient: Maj Allen Boothby, USMC

Presented By: Col Michael Mulligan, USMC; LtCol Richard Adams, USMC

#### Session I - Ammunition

Session Chair - Mr. Ralph Mazeski, US Army ARDEC, Picatinny Arsenal, NJ

1:30 PM 5.56mm Reduced Ricochet Limited Penetration (RRLP) cartridge

Mr. Sung Y. Kim, NSWC Crane, IN

1:50 PM Small Arms Ammunition Operational Temperature Stability Test and Evaluation

Mr. Charles T. Marsh, NSWC Crane, IN

2:10 PM Development of Non-Toxic Ammunition in Scandinavia

Mr. Thomas Mauritzson, NAMMO

2:30 PM Advanced BALL POWDER® Propellant Technology for Enhanced Lethality and

Green Ammunition

Mr. Steve Faintich, St. Marks Powder

2:50 PM Break In Exhibit Hall

#### Session II - ISSAP Session

Session Chair - Mr. Joel Goldman, Chief, JSSAP Office, US Army ARDEC

3:20 PM Joint Small Arms Capability Assessment Analytical Procedure

Mr. John Edwards, US Army ARDEC-JSSAP

3:50 PM Lightweight Small Arms Technologies (LSAT) Program Update

Ms. Korene Spiegel, US Army ARDEC-JSSAP

4:30 PM Design and Development of a 7.62mm Limited Range Coast Guard Round

Mr. Chad H. Sensenig, US Army ARDEC

4:50 PM Anti-Materiel Sniper Rifle Congressional Program

Mr. Neil E. Lee, US Army ARDEC

5:10 PM Plasma Transfer Arc Fabrication of Enhanced Performance Barrels

Mr. Kris C. Christou, MER Corporation

5:30 PM Reception in Exhibit Hall

#### Wednesday, May 17, 2006

7:00 AM Registration & Continental Breakfast

7:45 AM Administrative Announcements

7:50 AM NDIA Armaments Division Status Overview

Mr. Dave Broden, Broden Resource Solutions, LLC

8:00 AM The Marine Corps in the Global War on Terrorism

Lt Col Joseph A. L'Etoile, USMC, Commanding

Officer, 2nd Bn, 7th Marines

8:30 AM Soldier Weapons - Panel

Chair:

COL Carl Lipsit, USA, PM Soldier Weapons

Panel:

Mr. Richard Audette, PM Soldier Weapons

LTC Timothy Chyma, USA, PM Individual Weapons

Mr. Pete Errante, PM Crew Served Weapons

9:30 AM The National Small Arms Center

Mr. Frank Puzycki, ARDEC-JSSAP Mr. Gary Sniezak, FN Manufacuring

10:00 AM Break in Exhibit Hall

Session III - SOPMOD/SOF Weapons and Equipment

Session Chair - Mr. Charles Buxton, Naval Surface Warfare Center (NSWC) Crane, IN

10:30 AM SOPMOD Program Review

Mr. Gus Taylor, NSWC Crane, IN Mr. Barry Gatewood, NSWC Crane, IN Mr. Michael H. Jones, NSWC Crane, IN Mr. Richard Tousignant, NSWC Crane, IN Mr. Brian Kaneen, NSWC Crane, IN

11:30 AM SOPMOD – SOF Weapons Survey Report

Mr. Michael D. Iovino, The Wexford Group International

11:50 AM Luncheon

"The First Three Hundred Years of Small Arms (1326 – 1626)"

Dr. Stephen C. Small, JSSAP/ARDEC

Professional Service Awards

Recipient: LtCol Richard Adams, USMC

Presented by: Col Michael Mulligan, USMC

Recipient: Mr. Dave Broden

Presented by: Mr. Brian Berger

Recipient: Dr. Steve Small

Presented by: Mr. Brian Berger

Recipient: Mr. Marvin Maule

Presented by: Mr. Brian Berger



#### Session IV - International Programs Session Chair - Mr. Vern Shisler, JSSAP/ARDEC

1:10 PM Small Arms in NATO Transformation

Mr. Vernon E. Shisler, JSSAP /ARDEC

1:30 PM NATO Small Arms Weapons Research & Technology Study

Mr. Mark Richter, USMC, Quantico

#### SESSION V - Modeling and Simulation

Session Chair - Ms. Liliana McShea, US Army ARDEC, Picatinny Arsenal

1:50 PM Gelatin Impact Modeling

Mr. Mark Minisi, US Army ARDEC

2:10 PM Virtual Wind Tunnel Experiments for Small Caliber Ammunition Aerodynamic

Characterization

Dr. Paul Weinacht, US Army Research Laboratory

2:30 PM Special Weapon Observation Remote Reconnaissance Direct Action System (SWORDS)

Mr. Michael A. Zecca, US Army ARDEC

2:50 PM Anti-Sniper Infrared Targeting System

Dr. Daniel L. Lau, University of Kentucky

3:10 PM Break in Exhibit Hall (Last chance to view exhibits)

3:40 PM Experimental Characterization and Modeling of 5.56mm Ammunition

Mr. Anthony W. Williams, US Army Research Laboratory

4:00 PM Effects of Small Caliber Munitions through Intermediate Barriers

Mr. Chris Gandy, RDECOM-ARDEC

#### SESSION VI - WEAPON-RELATED ANCILLARY EQUIPMENT

Session Chair - Mr. Gary Sniezak, FN Manufacturing

4:20 PM UID Requirements

Mr. William E. Boyle, US Army ARDEC

4:40 PM Suppressors, Evolving to an Integrated Unit

Ms. Sophia Tassy, US Army ARDEC

5:00 PM M107 .50 Caliber Sound Suppressor

Mr. Joshua Semick, US Army ARDEC

5:20 PM Analysis of Ruptured Case in M249 using ANSYS/LS-DYNA

Mr. Clinton Fischer, US Army ARDEC

6:00 PM Cooking Demonstration and Dinner (Hyatt Regency Albuquerque)

#### Thursday, May 18, 2005

7:00 AM Registration & Continental Breakfast

7:50 AM Administrative Announcements

SESSION VII - Individual Weapons

Session Chair - Mr. George Kontis, Knight's Armament Company

8:00 AM The Swedish AK 5 Rifle Upgrade Program

Mr. Per G. Arvidsson, FMV (Swedish Defence Materiel Administration)

8:20 AM 5.56mm 30 Round Magazine Improvement Program

Mr. Adam L. Foltz, US Army ARDEC

8:40 AM SOF Combat Assault Rifle

Mr. Troy L. Smith, NSWC Crane

9:00 AM Sermon on the Mount!

Mr. Dick E. Swan, Atlantic Research Marketing Systems, Inc. (A.R.M.S.)

9:20 AM Break

Session VIII - Crew Served Systems

Session Chair - Mr. Troy Smith, NSWC, Crane

9:50 AM Advanced Lightweight Grenade Launcher (ALGL) Overview

Mr. Dennis Lambrecht, NSWC Crane

10:10 AM ARDEC Rapid Design Projects for Field Support

Mr. Michael Narus, US Army ARDEC

10:30 AM XM307 Integration

Mr. Robert Cavoretto, ACSW, GDATP

10:50 AM Closing Remarks

Adjourn to Buses for Lunch & Firing Demonstration

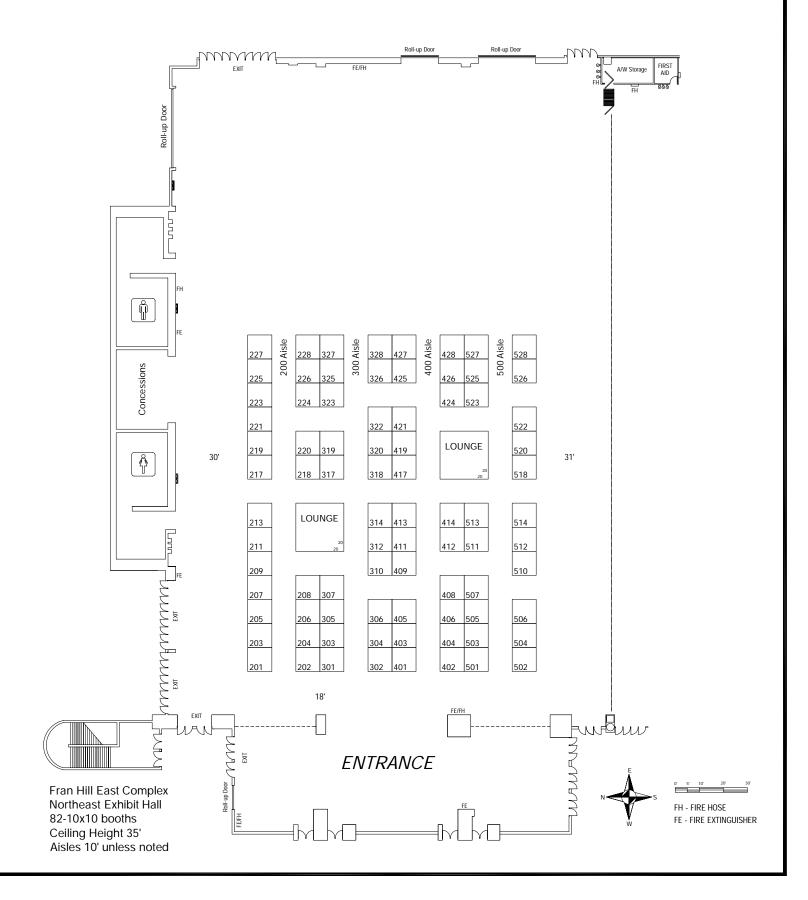
12:00 PM Lunch at firing range

SESSION IX - DOE and Contractor Firing Demonstration Mr. Sal Fanelli, Session Chair, USMC, Quantico, VA

1:00 PM Firing Demonstration

4:00 PM Buses return to Convention Center

#### 2006 Small Arms Symposium & Expo May 15-17, 2006 Albuquerque Convention Center Albuquerque, New Mexico



### Exhibitors-Company Name

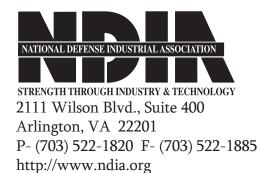
AAI Corporation	302
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### Exhibitors-Booth Number

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## Infantry Weapons Program Management Team PMM-132

Infantry Weapons Systems
Product Group - 13

LtCol. Rick Adams, Program Manager

5/23/2006 6610 - 2006

PM Infantry Weapons, LtCol Rick Adams

**Description:** PM Infantry Weapons is responsible for R&D, procurement and lifecycle management for all infantry weaponry employed by the warfighter.

- Crew Served Weapons
  - Machine Guns and Mortars
- Individual Weapons
  - Pistols
  - •Rifles to include sniper weapons
- Industry can help as we look to improve the technologies of weapons
  - Ammunition: lighter, increased incapacitation
  - •Weapons: reduced weight, improved reliability, reduced maintenance



PM Infantry Weapons, LtCol Rick Adams

PM IW Total Funding: Appropriations (\$K) Spending Breakout:

Appropriations (\$000)	FY 06 (includes Bridge Supplemental)	Estimated FY 06 Full Supplemental	FY 07	
RDT&E	4,023	0	2,382	
O&MMC	335	0	367	
PMC	114,528	52,693	12,047	

#### **Near-Term Program Initiatives**

- Infantry Automatic Rifle (IAR)- The IAR is a light weight, magazine fed, 5.56mm, individual weapon. The IAR enhances the automatic rifleman's maneuverability and displacement speed, while providing the ability to suppress or destroy not only area targets, but point targets as well. The IAR will replace the M249 SAW within each infantry battalion.
- Combat Pistol (CP)- Along with SOCOM the USMC is looking for a COTS Caliber 45 Pistol That Will Replace MEU(SOC) .45. The selected pistol will be reliable, accurate and will be ergonomically optimized.
  - Leverages Advancements In Technology (Weapon/Ammo/Accessories)
    - Increased Capability/Versatility
    - Leverages Existing Accessory Programs
      - Laser Aiming Module
      - Family Of Suppressors
    - Pre-Planned Product Improvement Efforts



#### **Future Program Initiatives**

#### **R&D** Investments

- Service Rifle Replacement- Looking to the future of weapons technology. Rifles with flexible configurations to adapt to changing missions.
- Digital Fire Control- The development of the digital fire control system for company and battalion mortars that will provide better accuracy and timeliness of fire response to a fire mission. This may eliminate the need for sights and aiming stakes.
- Shot Count Capability- In order to better sustain weapons determining the round count on the weapon makes it easier for the maintainers planning and is more cost effective deciding fix or replace criteria.
- Long Range Sniper Rifle- The Marine Corps has an interest in a long range (1100-1500m), medium caliber sniper capability to replace our M40 sniper rifle fleet in the outyears.

#### **O&MMC Investments**

• Enhanced .50 Cal- Looking to enhance current M2 including a Quick Change Barrel System and Flash Hider.



#### **Open Discussion Topics**

- Caliber Agility- We are conducting a preliminary screening to evaluate possible replacement of the current service round, or inclusion as a capability enhancer.
- Guidable Mortar Munitions/Caseless Ammunition- Working with Government S&T activities and JSSAP to increase first round hit capability and reduce the Marine's load, respectively.

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PM Infantry Weapons, LtCol Rick Adams

#### **Marine Corps Business Practices**

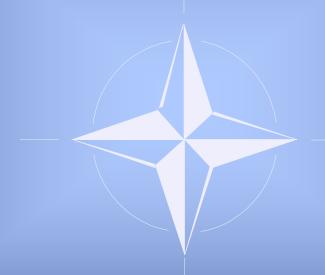
- We work on the margins- Low dollar amounts but responsive organizations decisive decision makers
- Perceived Rank Structure Disparity— If you want to "drop names" this is the wrong gun club.
  - Generals ———— Colonels
  - Colonels LtCols
  - − LTCs → Maj's or Capts
  - MAJsCapts or SNCOs

This isn't an affront, it's a way of life.

• We appreciate the relationships we have built with many of you and look forward to stronger ones in the future.



### NATO Small Arms Weapons Research & Technology Study



#### Per G. Arvidsson

Team Leader Technical Interfaces
NATO RTO Study SCI-178/RTG-043

Tel: +46-8-782 4181, Fax: +46-8-782 6412

E-mail: per.arvidsson@fmv.se Web-site: www.fmv.se



### Background



- The goal of this study is to optimize future infantry weapons.
- Today's weapons are not optimized as platforms for future sensors.
- Future rails should not only be a fastening point for sensors, but should also be able to supply them with power from a centralized battery, and provide data communication.
- The NATO RTO (Research and Technology Organization) will perform a study during 2006-2008 called: "Integration and interoperability issues for dismounted soldier weapon systems".



### RTO Study

- Three areas will be studied:
  - Technical interfaces.
  - Human factors analysis.
  - Power supply.
- A pre-study was done in 2005.
- The study will be done 2006-2008, and is named SCI-178/RTG-043.
- The RTO will publish a technical report in December 2008, which will most probably recommend standardization in several areas (technical interfaces, power supply, data communication etc.) with the goal to optimize future infantry weapons.



### Participating Nations

- 11 participating Nations: Canada, Germany,
   Spain, Great Britain, Italy, Netherlands, Norway,
   Romania, Slovakia, Sweden and USA.
- The study is chaired by USA.
  - Technical interfaces is chaired by SWE.
  - Human factors analysis is chaired by CAN.
  - Power supply is chaired by GBR.
- The RTO want the Nations to participate with users, engineers, scientists, and after careful consideration also with selected industries.



### Requirement for future Technical Interfaces

- Zero retention, repeatability and straightness
- Power supply
- Data transfer
- Physical characteristics
- Environmental resistance
- Sensors (incl . Fire Control Systems)



### Technical Interface Issues

- Protocol for testing zero retention, repeatability and straightness.
- Power supply
  - Galvanic contact
  - Induction
- Data transfer
  - Wired
  - Radio
- Physical characteristics
  - Survey of existing interfaces
  - Length adjustment requirement
  - Mechanical strength requirement
  - Recoil limits
  - Attachment mechanisms
- Environmental resistance acc. to MIL-STD 810F.
- Survey of sensors (incl . Fire Control Systems)



### Technical Interface Issues

- CAN and SWE will task industry to study a powered MIL-STD 1913 rail.
- All nations will request proposal from industry on future sensors, if a powered rail and data communication was available.



## Other possible TI's that could be standardized



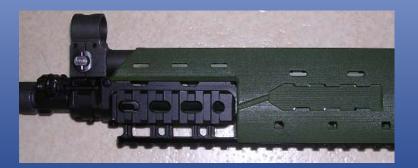


- Pressure Switch
- Flash Hider
- Muzzle Thread
- Bayonet Lug











### Human Factors Issues

- Ergonomics of weapons with attached accessories.
- Change of center of gravity with attached accessories.
- How does modern combat shooting training at short range and limited time effect the user while using his weapon with attached accessories?



### Modern accessories

- Most contain batteries, of different types.
- Batteries account for more than 50% of the mass and volume of the item.
- As most are mounted around the handguard, the center of gravity is moved forward.
- This affect the handling of the weapon.
- With a centralized power supply, the battery can be housed in the buttstock, thereby maintaining the center of gravity.







### Power Supply Issues

- Close cooperation with LG/1 "Dismounted Soldier Systems".
- Get data on batteries that are used in NATO – devices and the power consumption.
- Get "typical" NATO Soldier Day mission profile. What power is it likely to use?
- From this data create a baseline for a generic system.



### Time schedule

	2005	2006	2007	2008
Pre study SCI-130P				
SCI-178/RTG-043				
Technical report				*

SCI = Systems Concepts and Integration RTG = RTO Task Group



### RTO Study

### **QUESTIONS?**





### The Swedish ak 5 upgrade program

Presentation to

## "NDIA Small Arms Systems Symposium" May 18, 2006

#### Per G. Arvidsson

Product Manager Small Arms Systems Försvarets Materielverk (Swedish Defence Materiel Administration)

Tel: +46-8-782 4181, Fax: +46-8-782 6412

E-mail: per.arvidsson@fmv.se

Web-site: www.fmv.se



### Agenda

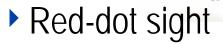
- Current Swedish small arms
- Ongoing Swedish programs
- ▶ The ak 5 upgrade program



### **Current Swedish small arms**



Some ongoing programs



Ammo (Green, APHC, Dim Tracer).

- ▶ Ak 5 upgrade.
- ▶ Barrett M107.



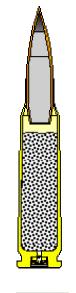
- NLW.
- Ksp 58 upgrade.
- FN M3M HMG.
- Short range ammo.
- ▶ Future grenade launchers.
- ▶ FX simunition kits.













## Development of the ak 5







## Ak 5 = M16A2

The ak 5 and M16A2 are technology vice equal:

- ▶ 1/7" NATO twist barrel.
- Magazine.
- Iron sights.



The FNC was the the original 1/7" rifle from the 1977-79 NATO-trials!



The M16A2 was the first 1/7" rifle adopted!



# The existing ak 5 family



The ak 5 is designed by Fabrique National of Belgium, and produced under license by FFV Ordnance (now Saab Bofors Dynamics) located in Eskilstuna, Sweden.

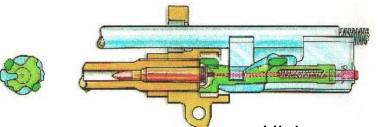
Data	ak 5	ak 5B
Weight unloaded (kg)	3.9	4.8
Length (mm)	1010 (750)	1010 (750)
Barrel length (mm)	450	450
Muzzle velocity (m/s)	930	930
Deliveries	1986-1999	1989

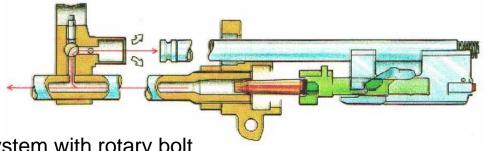


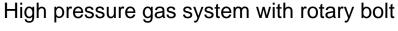
## What to do?

- No cold war = still many brand new weapons in depots.
- The existing ak 5 is well known for its high reliability and robust design, but is not suitable for integration in the upcoming Swedish future soldier program.
- The users requested:
  - ■ Rails.
  - Better ergonomics.













## Two alternatives

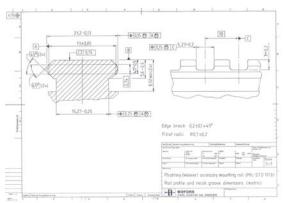
- Choice of buying a new weapon or modifying the existing.
- We choose to modify because of:
  - **Yellow** Lower risk.
  - Cheaper.
  - ■ Quicker.
- The original manufacturer Saab Bofors Dynamics was chosen as the contractor.





# Introduced changes on ak 5CF

- Generally
- ▶ Increased reliability: MRBS >2000.
- Black in stead of green.
- Upper receiver
- ▶ MIL-STD 1913 rail on the upper part of the receiver.
- New flash hider with better flash suppression.
- Only one gas position.
- ▶ New permanent bayonet lug for the ak 4 (G3) bayonet.
- New hand guard with rail at 6 o'clock.
- Lower receiver
- New adjustable butt stock.
- New ambidextrous selector lever.
- New pistol grip.
- Automatic bolt catch.
- Accessories
- New transparent plastic magazine.
- Removable forward grip.
- New tactical sling.
- Removed
- Ordinary iron sights
- Existing bolt catch



#### Summary:

- ▶ Rails.
- ▶ Ergonomics.
- ▶ Reliability.





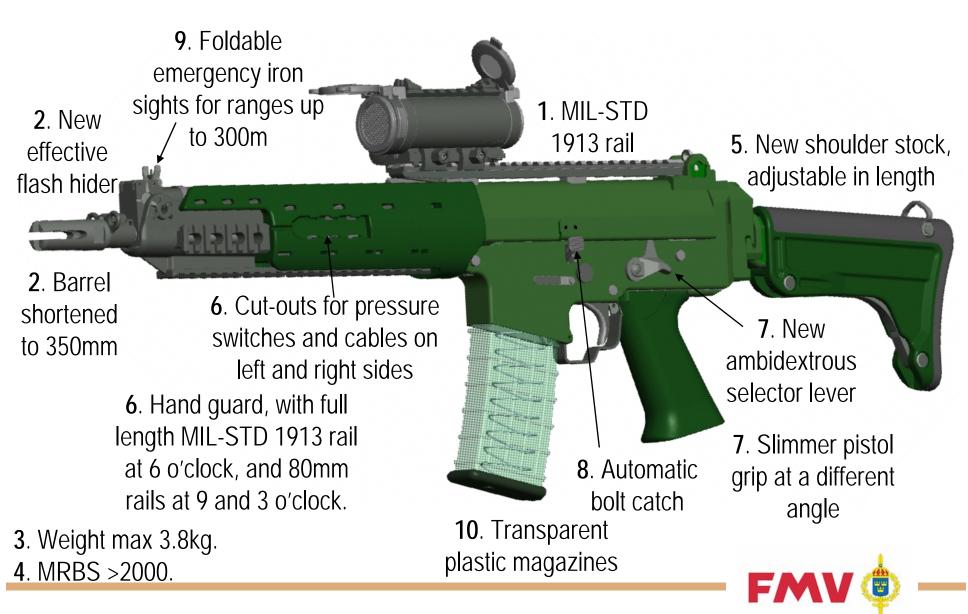
## User feedback

- ▶ 300 ak 5CF's in troop trials 2003-2005.
- More than one million rounds fired!
- MRBS was 3500!
- Some weapons fired more than 12,000 round without any broken parts!
- Users were enthusiastic, but:
  - ➤ Weapon is too heavy!
  - ➤ Weapon is too long!





# User priorities on ak 5C



# Mil-Std 1913 makes modularity possible!



US SOPMOD M4 Block 1 accessory kit



# Program schedule

- Industry contract in October 2005.
- ▶ Modification of 27,500 weapons in 2006-2009.
- First deliveries in June 2006.
- Ak 5C will be the primary weapon for Swedish Soldiers in the EU Nordic Battle Group.





## Swedish red dot sight for small arms



- Manufacturer: Aimpoint AB
- Type: Red dot sight
- Magnification: None
- Battery life: >10 years
- Rail: Mil-Std 1913
- Deliveries: 2003-2006
- Will be used on all rifles and machine guns.



# Possible accessories for the Red dot sight

- 3X magnification?
- Off Axis Viewing Device?
- **)** 2?
- Video?







Other accessories for ak 5C





- Magazine clip.
- Front grip.
- Tactical sling.
- Laser pointer (visual and IR).
- Illuminator (visual and IR).



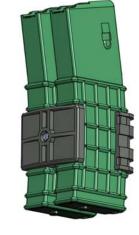


- Bayonet.
- Safety BFA.



- FX conversion kit.
- Telescopic sight.
- ▶ Bipod.













# Ksp 58 upgrade

- ▶ The ksp 58 (MAG/GPMG/M240) was a development initiated by Sweden in the 1950's.
- In use in Sweden since 1958.
- ▶ Test with 25 modified weapons in 2005-2006.
- Deliveries from 2008.





## **Summary**

- Sweden will upgrade at least 27,500 new ak 5 rifles.
- They will thereby remain modern for an additional 15 years.
- The Swedish soldier will therefore be equipped with a modern weapon at a moderate cost to the taxpayer.













# PM Soldier Weapons Overview for the Small Arms Symposium & Exhibition National Defense Industrial Association

16-19 May 2006

BG James R. Moran Program Executive Officer Soldier

COL Carl A. Lipsit PM Soldier Weapons Mr. Richard Audette Deputy PM Soldier Weapons



## <u>Agenda</u>

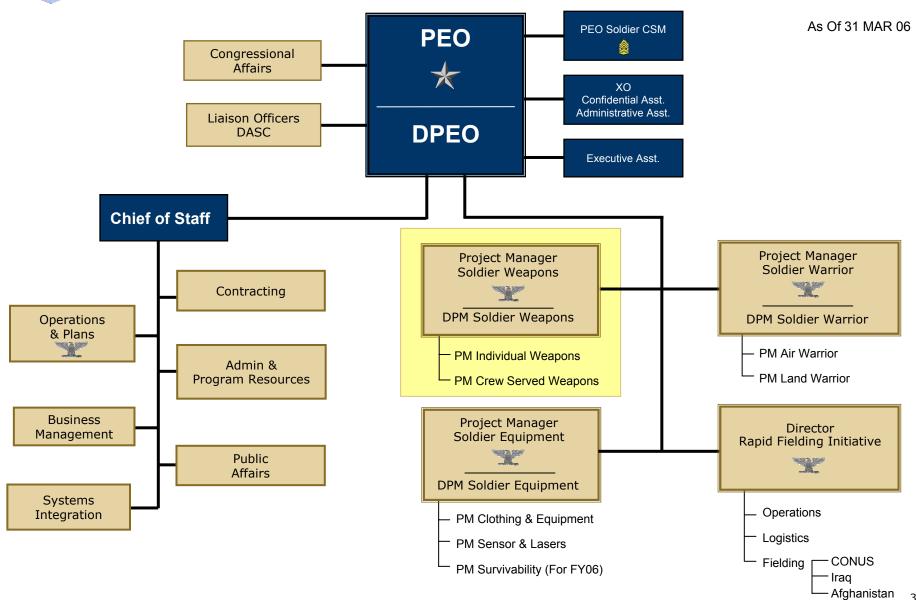


- PM Soldier Weapons
- PM Individual Weapons
- PM Crew Served Weapons
- Rapid Fielding Initiative



### **Program Executive Office Soldier**







## **Soldier Weapons Mission**



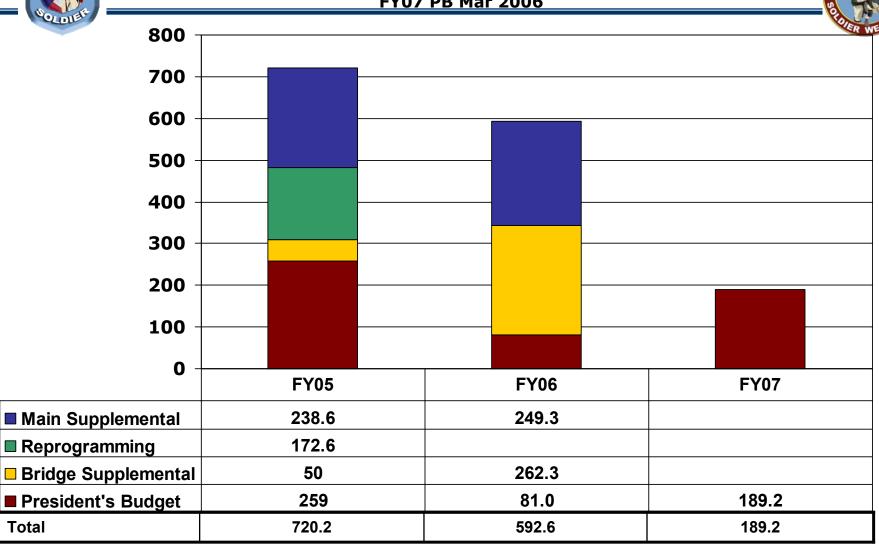
## **WTCV Funding Profile PMSW**



**Total** 

(Dollars in Millions)

#### FY07 PB Mar 2006



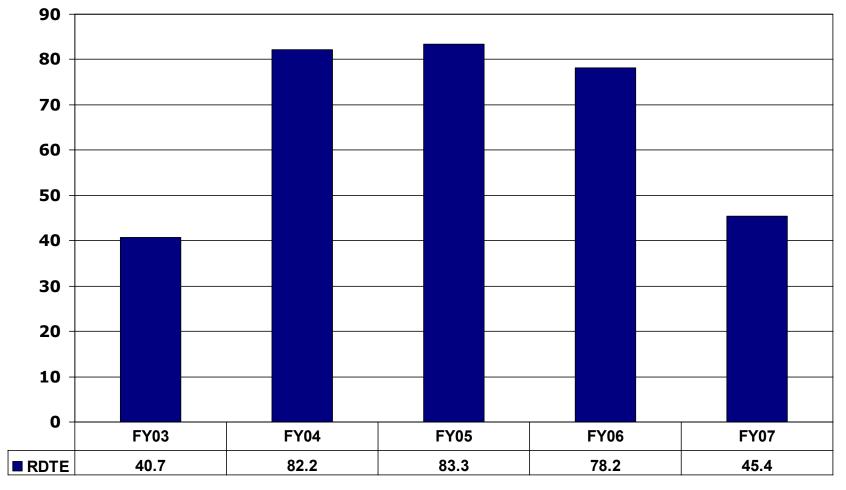
## **RDTE Funding Profile PMSW**



(Dollars in Millions)

#### FY07 PB Mar 2006







# Small Arms Weapons & Accessory Fieldings (August 2002 – March 2006)



#### Over 600,000 Soldiers in 60 BCTs & 95 EABs

Weapon / Item	Total Number Issued 02-05	
M4 Carbine	63271	
M16 Series Rifle	44179	
M500 Shotgun	11096	
M107 Sniper Weapon System	1626	
M249 Machine Gun	13911	
M240B Machine Gun	12077	
M240H Aviation Machine Gun	1364	
Mk 19 Grenade Machine Gun	2624	
M2 Machine Gun	8776	
M9 Pistol	13486	
M203 Series Grenade Launcher	3913	
M14 Rifle	4658	
M79 Grenade Launcher	77	
CROWS	48	
Backup Iron Sight	127896	
M68 CCO	181088	
M9 Magazine	131759	
M4/M16 Magazine	1614590	
3 Point Sling	98187	
Weapon Light	55412	
TA31F ACOG	11165	

M203 Day/Night Sight	6700
Modular Weapons System Kit	15547
M4 Forward Grip Bipod	4592
M4 Improved Buttstock	4082
M4/M16 Improved Cleaning Kit	5518
Multipurpose Tool	19813
M192 Lightweight Ground Mount	2120
Improved Spotting Scope	784
M24 Small Binoculars	41850
M145 Machinegun Optic	20369 (RFI Only)
M249 Rail	20442
M249 Short Barrel	18088
M249/M240B Spare Barrel Bag	14574
M249 Collapsible Buttstock	2681
M249 Soft Ammo Pack (100&200 Rd.)	46393
M240B Rail	2934 (RFI Only)
M240B Combat Ammo Pack - 85 rd.	7923





## **United States Air Force**



# JSSAST Small Arms Program Review

Col. Charles Beck Chief, Operations Division HQ Air Force Security Forces Center Lackland AFB, TX



#### **Overview**



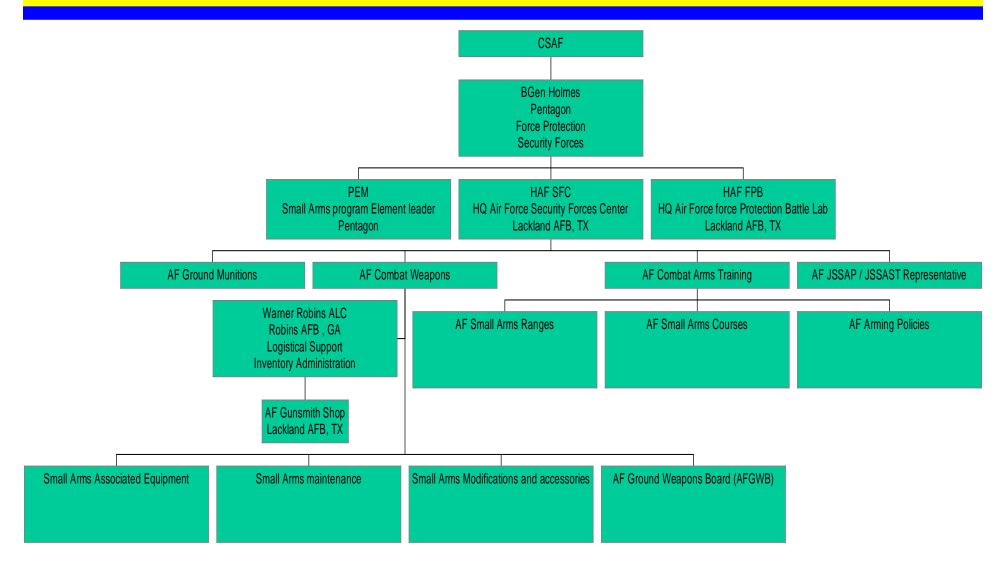
- Organization
- M4 Carbine
- M240B Machine gun
- M870 MCS
- M9 Pistol Replacement
- Emerging Requirements
- Opportunities for Industry
- Air Force Small Arms Top Priorities



#### **USAF**



### Program Executive Office Small Arms





#### **M4 Carbine**



#### **Description**

The M4 Carbine is the newest member of the USAF M16 series of weapons. The Security Forces version will be equipped with an M68 Close Combat Optic (CCO) and a Back-up Iron sight. The CCO is compatible with our night vision equipment.

#### **Current Status**

M4 has replaced all daily use M16A2s, GAUs and GUUs for Security Forces, AF Special Operations Forces and select Group A/B AFSCs utilizing these weapons

M203, A1 and A2 mounting along with DNS and other enhancements seen in Army RFI and SOPMOD Programs are being fielded.

#### **Delivery Schedule**

Deliveries began Dec 02. Currently we have approximately 46,000 M4s in use and new requirements being ordered monthly through FY08.

Approximately 1,300 M4A1 Carbines have been delivered.

Magnified 4x ACOG Day Optical Sights have been fielded for required missions as Designated Marksmen





#### **M240B Machine Gun**



#### **Description**

The M240B is the replacement for the M60 medium machine gun.

#### **Current Status**

Currently we have issues with receiver separation / breakage... due to hydraulic buffer quality deficiency. Coordinating with USA to get new shorter barrels, improved / collapsible stocks, improved bipods and other changes approved and integrated.

#### **Delivery Schedule**

Deliveries began Oct 02. All initial orders have been filled and we are on sustainment for these assets. Approximately 3,200 in use.





#### **M870 Modular Combat Shotgun**



#### **Description**

Type: pump-action

Gauge: 12: Capacity 5-7 Rounds

Barrel length: 355 mm (14 in.), 457 mm (18 in.)

Weight: 3-3.5 kg

Remington 870 "Wing master" was introduced 1950

1970s adopted by US Military Magazines for 7 or 8 rounds

The latest addition is the 870 Modular Combat Shotgun (MCS). The 870 MCS kit consists of the receiver and magazine tube (3 rounds base capacity), plus several detachable components, such as barrels (10", 14" and 18"), -- Receiver Rail

can mount new optics

#### **Delivery Schedule**

All 8,328 have been delivered and over 4,000 have been fielded. Security Forces have priority. Some PQDR's have been submitted for a crack in the butt stock. Non-critical area affected and still in use.

#### **Current Status**

First time AF will have a shotgun able to be rapidly adapted to any mission. Standardized accessories and parts will allow maximum flexibility while maintaining safety





#### **M9 Pistol**



#### **Description**

Purchased and fielded over 2,200 M92FS (current civilian equivalent to M9) to replace aging small arms that have nearly doubled their service life. M9s are failing in training and possible combat failures due to shot count are becoming a real world concern.

## Delivery Schedule

Originally, approximately 30,000 Model 92FS were ordered. Delivery scheduled to continue through Oct 07.

AF has 2,325 M11 pistols fielded and has just acquired approximately 165 through GSA system and is trying to procure more. Increased ops and new requirements for concealed carry pistols.

#### **Current Status**

Replacing current training assets and filling new requirements due to increased operations. Spare parts are difficult to get. Procurement of any stocked quantities for sustainment has slowed. USAF is directly involved with Joint Combat Pistol Program and plans to push that effort forward.





# Emerging requirements for Joint Synchronization



## Future programs AF wants involvement

- 1. Joint Combat/Future Pistol
- 2. Non-lethal
- 3. Solutions to Capability gaps identified in JSSACA



# Opportunities for Industry



- Fire-control / Tactical Engagement
- Simulators
- IR / Thermal Accessories
- Improved Munitions
- Lubrication / Coatings / Camouflage



# USAF Top Issues



- 1. Replenish decaying handguns and move forward with USA on Joint Combat Pistol.
- 2. Operational decision on quantity of M4 / M16A2s to acquire or maintain.
- 3. Adopt a streamlined process for fielding new small arms, accessories and related equipment.



#### **Future Requirements**



- Air Force role as defenders of Air Bases has changed. We are now fighting
  the same battles in the same space as other services. Our convoy security
  operations along with patrols have transformed the Air Force as a whole and
  will continue to. We will still rely heavily on the other services for small arms
  lead but we will be assuming a more proactive role.
- "Preparing for the future will require us to think differently and develop the kinds of forces and capabilities that can adapt quickly to new challenges and to unexpected circumstances. An ability to adapt will be critical in a world where surprise and uncertainty are the defining characteristics of our new security environment."
  - » Donald Rumsfield, 21st Century Transformation
- "Get outside the wire ... and get out there and begin to think about what's a threat to this airfield, what do we have to do to defend it so we can operate 24 hours a day, 7 days a week, in a true joint sense, and in a true combatant sense so that there's no threats to this airfield that we haven't thought about."

General T. Michael Moseley, AF Chief of Staff 11 Oct 2005 American Enterprise Institute Speech







### **Small Arms UID**

17 May 2006





### **Agenda**



- UID Requirements (Mike Friedman, PM Soldier Weapons)
- Summary of M9/M240 Environmental Testing (Bill Boyle, ARDEC)
  - Initial
  - Hot/Cold
  - Salt/Fog
  - Chemical



#### What Is UID?





 UID is a 2-D data matrix used to uniquely identify an item.





#### What Needs To Be Marked?



- Any serialized managed item
- Any item that has a value of over \$5,000.00
- Any item the PM wants to be coded
- · GFM/GFE
- Controlled inventory
- Mission essential
- PM Implementation plan requires one mark per weapon on the serially tracked component (i.e., Lower receiver)





### **REQUIREMENTS**





 MIL-STD-130M, Establishes the marking requirement on the item.

 DFARS 252.211-7003 Defense Federal Acquisition Regulation Supplement, identifies the data submission requirements.



# When Does This Need To Be Implemented?



#### **New Production**

Industry needs to Implement NOW

 All new procurements have DFARS clause as part of the contract

All options have this added as they are exercised



# When Does This Need To Be Implemented?



#### **Government Inventory**

To be marked at Government Depot

All legacy items must "comply" by December 31, 2010

Will not mark inactive systems (i.e. M1, M14, M60, M1911)





#### **Additional Information**





- WWW.IUIDToolkit.com
- WWW.UIDsupport.com



#### **Pilot Project Test Summary**



- Initial testing has been conducted on various marking methods, testing includes:
  - Hot
  - Cold
  - Icing
  - Salt Fog
  - Chemical compatibility
  - Blowing Sand

# TEAM

#### **Milestones**



 Phase II Qualification Testing completed 20 Mar 2006

- Reviewing test results and continuing to implement approved plan
- Brief Industry

 Developing detailed implementation at Anniston Army Depot

Develop and Field Current and Future Small Arms for the Army



#### **Test Items**



		# of samples			
Method	Coating	М9	M240		
	Krylon	Х	5		
	Bare Phosphate	Х	10		
Laser coat and discolor	Anodized	8	Х		
	DataLase Clearcoat	7	5		
	Aluma Hyde II	5	5		
Laser etch & clear coat	Aluma Hyde II	5	7		
	DataLase Clearcoat	5	5		
	Evershield	5	7		
	No coating	5	7		
	No Coating	Х	12		
	Ahyde II	Х	5		
Deep laser engraving	Datalase	Х	5		
	Krylon	Х	5		
		10	Х		
Tesa Tape		20	15		





#### Hot Test

- Samples conditioned to 155 deg F for 24 hrs
- Temperature increased to 220 deg F for 1 hr then returned to 155 deg F for 4 hrs
- Repeated for six cycles
- Upon completion of test markings examined for damage and readability





#### Cold Test

- Weapons conditioned to -55 deg F for 24 hrs
- Temperature increased to 220 deg F for 1 hr
   then returned to -55 deg F for 4 hrs
- Repeated for six cycles
- Upon completion of test markings examined for damage and readability

Develop and Field Current and Future Small Arms for the Army





### Icing Test

- Samples conditioned to 20 deg F for 24 hrs
- Water was sprayed onto the test samples every hour until ice the thickness of 1/8 inch achieved
- Samples returned to ambient temperature and markings examined for damage and readability

Develop and Field Current and Future Small Arms for the Army





### Salt Fog

- M9 samples subjected to 5% salt solution for 336 hrs
- M240 samples coated with CLP and subjected to 5% salt solution for 48 hrs
- Upon completion of test markings examined for damage and readability





- Chemical Compatibility
  - Test samples exposed to Army standard chemicals for a period of 24 hrs
- Upon completion of test markings examined for damage and readability





#### Sand and Dust

- M240 samples subjected to 3.5 lbs of blowing sand and dust
- Sand nozzle directed on the mark being tested
- Upon completion of test markings examined for damage and readability



#### **Sand and Dust Test**





**Sand Chamber** 

#### After Sand testing and before cleaning





# Test Results (Readability)



		Init	ially	Aff	After hot		After	Cold	After icing		After	chemical
Method	Coating	M9	M240	M9	M240		М9	M240	М9	M240	М9	M240
	Krylon	NA	2/2	NA	2/2		NA	2/2	NA	2/2	NA	2/2
	Bare Phosphate	NA	1/4	NA	0/4		NA	1/4	NA	1/4	NA	1/4
Laser coat and	Anodized	3/4	NA	4/4	NA		3/4	NA	4/4	NA	3/4	NA
discolor	DataLase Clearcoat	3/3	2/2	3/3	2/2		3/3	2/2	3/3	2/2	3/3	2/2
	Aluma Hyde II	2/2	2/2	2/2	2/2		2/2	2/2	2/2	2/2	2/2	2/2
	Aluma Hyde II	2/2	1/3	2/2	1/3		2/2	2/3	2/2	1/3	2/2	1/3
Laser etch &	DataLase Clearcoat	2/2	2/2	2/2	2/2		2/2	2/2	2/2	2/2	2/2	2/2
clear coat	Evershield	2/2	2/4	2/2	2/4		2/2	4/4	2/2	3/4	2/2	2/4
	No coating	2/2	2/3	2/2	2/3		2/2	2/3	2/2	1/3	2/2	1/3
	No Coating	3/4	6/6	3/4	5/6		3/4	2/6	1/4	4/6	Х	4/6
Deep laser engraving	Ahyde II	NA	1/2	NA	0/2		NA	0/2	NA	0/2	NA	0/2
	Datalase	NA	2/2	NA	2/2		NA	2/2	NA	1/2	NA	1/2
	Krylon	NA	2/2	NA	2/2		NA	2/2	NA	1/2	NA	1/2
Tesa Tape		9/9	8/8	9/9	8/8		8/9	8/8	8/9	7/8	8/9	8/8



# Test Results (Readability)



#### Hot/cold wpns

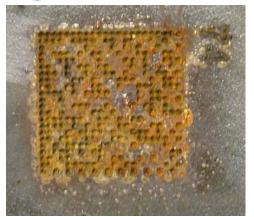
		Initially			After Salt Fog				sand and dust
Method	Coating	M9 M240			M9	M240		M9	M240
	Krylon	NA	3/3		NA	0/3		NA	2/2
	Bare Phosphate	NA	0/4		NA	0/4		NA	1/1
Laser coat and discolor	Anodized	4/4	NA		3/4	NA		NA	NA
	DataLase Clearcoat	3/3	3/3		0/4	0/3		NA	2/2
	Aluma Hyde II	3/3	3/3		0/3	0/3		NA	2/2
Laser etch & clear coat	Aluma Hyde II	3/3	4/4		0/3	2/4		NA	1/1
	DataLase Clearcoat	3/3	3/3		0/3	0/3		NA	2/2
	Evershield	3/3	3/3		0/3	2/3		NA	2/2
	No coating	3/3	3/3		0/3	1/3		NA	1/1
	No Coating	3/3	3/3		0/3	0/3		NA	2/2
Deep laser engraving	Ahyde II	NA	3/3		NA	0/3		NA	0/1
	Datalase	NA	3/3		NA	0/3		NA	1/1
	Krylon	NA	3/3		NA	0/3		NA	1/1
Tesa Tape		8/8	4/4		8/8	4/4		NA	2/2

Note: M9 not tested with Sand/Dust due to lack of fixture



#### After Salt/Fog Testing (M240)





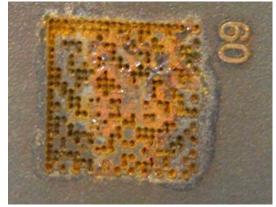
M240-74A deep laser, Ahyde II w/clear coat



M240-49 laser etch w/clear coat, Ahyde II



M240-41 laser etch w/clear coat, Ahyde II



M240-60 deep laser w/clear coat (Krylon)

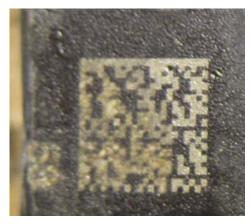


M240-2A DATALASE
Paint w/clear coat,
Ahyde II

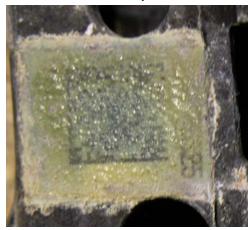


#### After Salt/Fog Testing (M9)





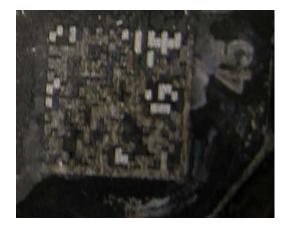
M9 9-53 laser etch w/clear coat, Aluma Hyde II



M9 9-25 Datalase paint, Aluma Hyde II w/clear coat



M9 9-38 laser etch w/o coating



M9 9-45 laser etch w/clear coat (Evershield)

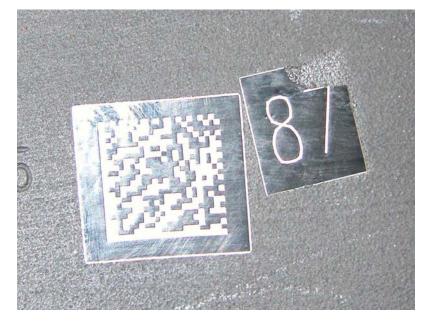
Corrosion Matrix		Amount of corrosion after salt fog  M9  M240											
	Readable			Unreadable			Readable			Unreadable			
		None	Slight		Moderate Seve			None	Slight		Moderate	Severe	
Method	Coating												
Laser coat and discolor	Krylon	NA	NA		NA	NA		0	0		1	2	
	Bare Phosphate	NA	NA		NA	NA		?	?		?	?	
	Anodized	2	0		2	0		NA	NA		NA	NA	
	DataLase Clearcoat	0	0		3	1		0	0		0	3	
	Aluma Hyde II	0	0		2*	0		0	0		0	3	
	Aluma Hyde II	0	1		1	1		1	2		0	1	
Laser etch &	DataLase Clearcoat	0	0		0	3		0	1		0	2	
clear coat	Evershield	0	0		2	1		0	2		1	0	
	No coating	0	0		1	2		1	0		2	0	
Deep laser engraving	No Coating	0	1		2	0		1	0		2	0	
	Ahyde II	NA	NA		NA	NA		0	0		1	2	
	Datalase	NA	NA		NA	NA		1	0		2	0	
	Krylon	NA	NA		NA	NA		0	0		3	0	
Tesa Tape		8	0		0	0		4	0		0	0	



### **TESA Tape**







M9 M240



### **TESA Tape**





M9



M240



#### **Test Results Summary**



- Some marks couldn't be seen on the weapons (laser discolor)
  - Soldiers wouldn't be able to find them
- Distance to hold scanner from the mark continuously fluctuated depending on the mark to be read
  - Could result in multiple scans before mark read
- All laser markings were unreadable after Salt/Fog test



#### **Test Results Summary**



- Laser etching w/clear coat performed well but clear coat unable to survive Salt Fog Test
  - Blistering was evident on two of the marks
  - One of the two was still readable
  - Multiple attempts were necessary to read the marks
- TESA tape performed well but some durability concerns with cracking/peeling
  - Some tearing on M9 pistol when placed too high on the back strap
  - Personnel were able to peel corner of the label



#### **Test Results Summary**



 Follow on testing was conducted using various labels and clear coatings

 All of the labels tested (three types) passed the salt fog test and chemical compatibility test

 All of the clear coatings tested (four types) passed the salt fog and chemical compatibility test



#### Recommendations



- Adhesive labels or name plates with a clear coat applied is recommended
  - Clear coat prevents cracking or peeling and enhance durability of the tape
  - Use darker background (gray) rather than white
     2D data matrix to reduce reflectivity

 Laser and other engraving techniques not recommended for UID application to small arms

Develop and Field Current and Future Small Arms for the Army





### Questions?

Develop and Field Current and Future Small Arms for the Army

#### **Armament Division**



### **Joint Small Arms Systems**

# National Defense Industrial Association (NDIA)

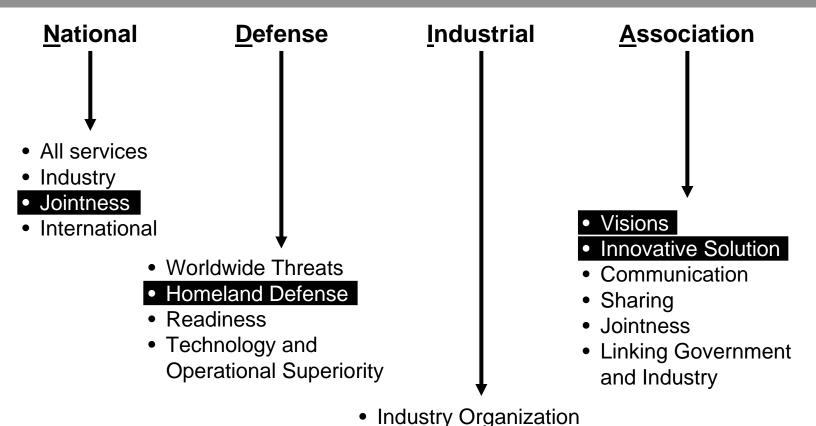
**Armament Division** 

**2006 Division Status** 

15-18 May 2006

#### The Links – Who, What, Why





**An Organization Ensuring Strength Through Industry and Technology** 

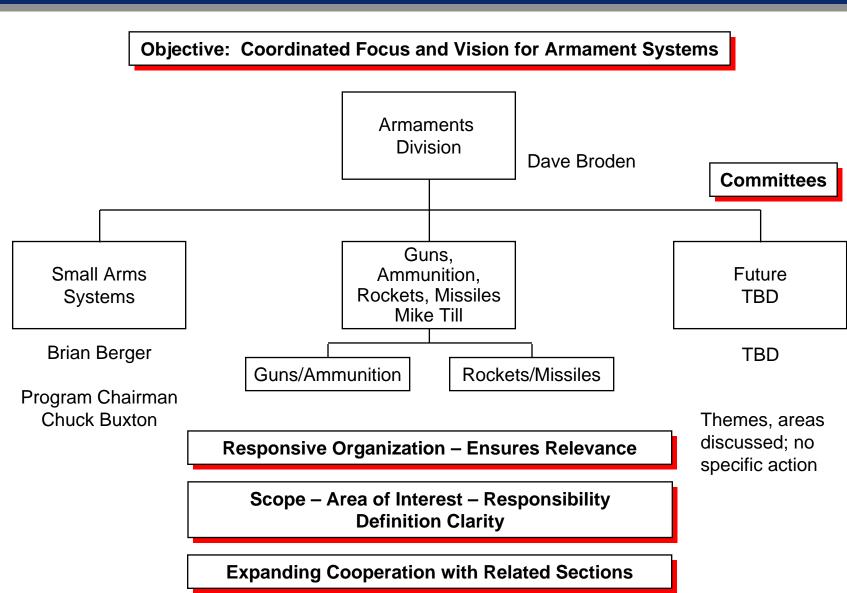
Resources

Spokesman for Industry

Capability/Readiness

#### Leadership





#### **Committee Focus for Symposium Attendees**



- Selecting a Theme--- Relevant, Timely, and with a Vision
- Including keynoters and presentations that <u>communicate effectively</u> to inform and challenge the attendees
- Offer <u>opportunities for attendee participation</u> thru questions, panels, exhibits, demonstration, and networking.
- Address <u>status of present capability</u> while building <u>awareness of evolving</u> need, new technology, and new systems.
- Providing the framework for technology, system, or capability opportunities to enable meeting the Joint Service needs.

#### **Small Arms Systems**



Meeting the Needs of Our Joint Ground Forces in the Fight Against Terrorism and Developing the Tools for Future Combat

Address and Focus on the Theme

**DoD and Homeland Defense Capabilities** 

- Joint Force operations and capability
- Response to asymmetric threats
- Adapt systems and technology for operational flexibility Jointness
  - Responsiveness

- Push technology envelope(s)
- Push integration efficiencies
- Add functional capabilities
- Introduce new systems
- Ensure readiness and capability

"Lessons Learned" — Readiness/Capability — Responsive Force — Jointness — Technology Change

**Shape the Future** — **Enable the Force** 

#### **Linking to Theme**



## Meeting the Needs—Enabling Forces—Defeating Terrorism-Future Tools for Combat ■

- Understanding the Need
- Joint Requirement(s)
- Requirements Pull
- Technology Push
- Readiness/Capability/Responsiveness
- Direct Integration
- System Integration Adaptations
- Spiral Development
- Supportability

- Threat Specific Solutions vs. Capability Driven and Adaptable
- Operational Flexibility and Responsiveness
- Industrial Base Readiness
- Spiral Development

#### **Response to Symposium Theme**

Adaptable, Innovative, Visionary, Capability Focused

#### **Committee Scope**



#### **Small Arms Systems**

- Individual weapon(s)
- Crew served weapon(s) (e.g., ≤ 40mm)
- Lightweight Systems
- Ammunition
  - Enhanced/lightweight
  - "Green"
- Full life cycle management
- Supportability
  - Training
  - Logistics
- Target Acquisition/Fire Control System (TA/FCS)
- Remote Stabilized Turret System
- System Integration
- Networked capabilities
- Non lethal
- Homeland Defense systems

#### **Gun and Missile Systems**

#### **Guns and Ammunition**

- Medium caliber systems
- Tank systems
- Mortar systems
- Artillery systems
- Naval gun systems
- Aircraft/helicopter systems
- Precision systems
- Platform Integration
- Manned/robotic applications
- System integration
- TA/FCS
- Supportability
- Life cycle management
- Stabilized Turret System

#### **Missiles and Rockets**

- Tactical missiles and rockets
- Shoulder Fired Systems
- Ground launched
- Aircraft/helicopter launched
- Precision Systems
- System Integration
- Manned/robotic applications
- Life cycle management

**Synergism** 

\_

**Commonality** 

Common Enabling Technologies, Modeling/Simulation, Man-Tech

**Links to Other Committees** 

### **Small Arms Systems Vision Forward**



- •Maintaining strong Small Arms community of government, industry, academia etc. focused to ensuring the technology, systems, and capabilities are state of art, ready, and responsive and linked to joint service needs—R&D and Production
- •A forum for <u>addressing and communicating changes</u> in requirements, evolving technologies, and new systems—
- •Continuing the tradition of Small Arms Systems focus on weapons and ammunition and adding the "new"—full system vision of fire control, networks, smart capabilities that enable the small arms user to do his job better
- •Enabling the Small Arms community a forum with opportunity for networking resulting in co-operation, sharing, and understanding

### **Armament Division Forward Vision**



Symposium Program Content Focus

**Balance Program Presentations** 

Vision of The Future—Requirements, Technology, Systems Discussion of Current Activities, Needs, Issues Include Enabling Technologies and Systems

Increase Industry Presentations of Current, Evolving and Future

Technology

**Systems** 

Industrial Base

Ensure Communication of Industry Initiatives and Innovation

- Symposium Attendee Input on Topics of Interest
- •Executive Committee Initiatives to Seek Presentations on Key Topics

### **Armament Division Focus Topics**



#### 1. Ensuring Capability for the Warfighter

Current Systems
Refurbishment/Repair
Expendables

### 2. Responding to Urgent Technology/System Needs

"Lesson Learned" Responses
Adapting to New Threats and Conditions

### 3. Maintaining and Adapting the Industrial Base

DOD Organic Base Industrial Base Helping to shape the future capability

### 4. Establishing and Transitioning New Technology and Systems

Requirement Process Effectiveness
Addressing Total System Integration Descriptions
Program Decision Milestones
Schedules/Spiral development and Technology Insertion
Funding

### **Armament Division Focus Topics (continued)**



#### 5. Understanding Budgets and Funding

**Shaping Development Plans leading to New Systems Maintaining Production to ensure Readiness** 

### **6. Transitioning the Workforce**

Attention to DOD Technical Manpower Study-Mentoring effectively
Enabling the entry Workforce—Ensuring skilled resources

### 7. Evolving New Technology To Readiness for System Applications

**Understanding the Need** 

"Maintaining Innovation" thru effective Industry and Government investments

**Establishing vision of Small Arms Systems in the Future** 

- 8. Maintaining Technical Data Packages (TDP's) and related data to ensure timely and quality production
- 9. Increasing Executive Committee representation of all services

### **Bottom Line**



## NDIA Focus → Responsive to Industry/DoD Community → Ensures Relevance

Addressing Issues Critical to Small Arms Systems— Supporting Joint Service Objectives

#### **Armament Division Focus**

- Expanded participation
- Resource for government and industry
- Linked to key DOD and service strategies
- Capture "lessons learned" → ensure readiness → shape future
- Encouraging leverage of complementary systems
- Effective use of exhibits, demonstrations, and tours

**Establishing Vision for 21st Century Relevance** 

**Applying System Synergism to Meet Transformation Goals** 

### 2006 Symposium



**Guns and Ammunition** 

**Rockets and Missiles** 

### **Enhancing Our Capability and Evolving for Tomorrow**

#### Addressing the Theme!

- Joint Capability
- Joint Requirements
- Readiness Capability

#### **Applying Common Advanced Technologies and Integrated Systems**

- Capability focused complementary integrated systems
- Strengthening Legacy Systems while evolving "new"
- Address key force multipliers
  - PrecisionSituation awareness
  - MobilityLethality
  - Communication
- Planning and implementing Spiral Development

- Building on "lessons learned" for future readiness
   Priority to supporting the Warfighter
- Ensuring responsive industrial base capability
- Attention to life cycle management

**Enabling an Integrated Joint Force Capability** 

### **Symposium Attendance Realizing Growth**



- Gun and Missile Systems
   Attendance---350-500 in last 5 years
- •Small Arms Systems

Attendance—400-550 in last 5 years

**Expanded Participation** 

**New Attendees and repeat attendees** 

**Attendee Comments Impacting Program Content** 

**Growth of Exhibits** 

Continued International participation

- Interest and Activity Continues to Grow
  - •Armament Division meets Needs of Government and Industry

### **Symposium Observations**



### Linking NDIA and DoD Realized

- Improved <u>links</u> to DoD and service <u>thrusts</u> and <u>initiatives</u>
- Interest in "after action reports" "<u>lessons learned</u>" → <u>industry</u>
   responsiveness → <u>addressing challenges</u>

### **Symposium Quality and Communication Demonstrated**

- Presentation <u>quality</u> improvements and "So What" <u>benefit messages</u> have <u>added value</u>
- Focused interest in systems level presentation vs. technology unless technology offers payoff vision
- <u>Industry adjusted</u> to intellectual property concerns and expanded participation positively
  - Industry worked with vision

### **Armament Division Success**



**Guns and Ammunition/Missiles and Rockets** 

**Small Arms Committee** 

Value Added Has Been Demonstrated

**Leadership to Strengthen the Armament Community** 

Challenge: Applying Technology, Systems for Future Force

**Ensuring Readiness . . . . Responding to the Challenge Advancing Superior Capability** 

**Symposium Benefits Confirmed** 

**Increasing Interest/Participation** 

### **2006 Armament Division Highlights**



Leadership for National Small Arms Consortium and Center

**Executive Committee** 

Research Committee and Subcommittees

- Participation in Industrial Base Status and Needs Briefings
   Communication of Situations, Changes and Actions
- Armament Division Executive Committees demonstrated Leadership

Multiple Meetings

**Expanded Participation** 

Shaping the Future

 NDIA Armament Division Contacted by Government and Industry for expertise to address specific needs---

Talent and Experience benefited specific activity

### **2006 Armament Division Highlights**



- Symposium Attendance Strong and Growing
- Symposium Exhibits Effective and Quality Enhanced
- Integration of Guns and Ammunition and Rockets and Missiles provides strong system and technology synergism—realizing benefits
- Executive Committee activity strengthened an increased
- Government and Industry Partnership in Division leadership demonstrated

Armament Division leadership strength enables strategic focus to address current and future needs

### **NDIA International Symposium Links**



### **Objective:**

International cooperation and integration of symposiums benefiting industry and Department of Defense to encourage partnerships for development, production, and interoperability

- **Approach:** Coordination of NDIA Armament Division programs with "Symposium at Shrivenham" The Royal Military College of Science
  - Common presentations and panel participants is a strong "open door" resource

**European Small Arms and Cannon Symposium** 22-24 August 2006

### **2006 Top Defense Issues**



- Issue 1: Sustain the Defense Industrial Base
- Issue 2: Sustain Overall Military Readiness While Continuing the Global War on Terrorism and Preparing for Future Defense Transformation
- Issue 3: Improve the Integrity and Responsiveness of the Acquisition Base
- Issue 4: Improve Small Business Opportunities
- Issue 5: Strengthening the National Security Workforce

**NDIA Board of Directors Approved Focus** 

**Established by Government Policy Advisory Committee** 

**Look to Web Site for Full Details** 

These Issues are NDIA Membership Voice to Congress

### **NDIA Communications**



- National Defense Magazine
  - Emphasis on relevant and timely topics
  - Frequently source of media, DoD, and Congressional reference
- Website
  - Symposium presentations available attendee access
  - Complementary information
  - Full list of activity
- Top public policy issues prioritized addressed to Congress strengthen the community

**NDIA Messages and Content Has Impact** 

and

Website Used Extensively as Resource

### **Armament Division 2006 Challenges**



- Ensuring Symposium Presentations offer <u>"Value Added"</u> content
- <u>Focusing Symposium Topics</u> to address—"Critical—Relevant—Priority subjects
- •Enabling <u>communications</u> of evolving Small Arms technology, systems, and operational integration
- Evolving <u>Symposium/Exhibit format</u> to enhance communication and understanding ---apply innovation effectively
- Integrating Symposium Format enabling <u>Attendee input and interaction</u>—use new presentation formats and technology
- Providing individual <u>expertise</u> in response to requests for support
- •Matching <u>Attendee topic interest</u> to the program structure---Solicit topics of interest as well as presentations when issuing call for papers.
- Become recognized as a <u>resource to go</u> to for "Problem solving" or assessing needs or alternatives--- support special studies.

### **Leadership Vision**



#### **NDIA Armament Division Is:**

- A <u>relevant</u> voice and forum
- Responsive to DoD community and industry challenges
- A forum for DoD/industry <u>interaction discussion</u> of "lessons learned" and needs
- <u>Supporting</u> national defense through people resources, networking, and symposiums
- <u>Transforming</u> to ensure relevance to changing military, geopolitical environments, technology, and industrial base resources

The NDIA Community is the Resource of Choice For Excellence in National Defense Topics/Communications











### XM307 Integration

### Increased Platform Lethality















2006 Joint Services Small Arms Systems Annual Symposium May 18, 2006

Robert Cavoretto, Sr. Program Manager – XM307

**GDATP** 

### XM307 Program

#### XM307 System Design & Development (SDD)

- **✓**PM-CSW ARDEC
- ✓GDATP Weapon & System Integrator
- ✓GDOTS 25mm Ammunition
- ✓ Raytheon Surrogate Target Acquisition Fire Control
- ✓ Initiated Apr04 for XM307 Advanced Crew Served Weapon (ACSW)
- ✓ Transition to XM307 Remotely Operated Variant (ROV) for FCS



### XM307 Weapon System **ACSW & ROV**

### **Common Attributes**

- ✓ Light Weight
- ✓ Reduced Recoil
- ✓ 25mm HEAB & AP Ammunition
- Accurate and reliable

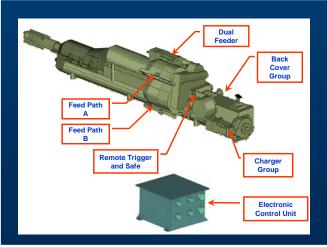
#### ACSW

- ✓ Ground mount and dismountable vehicle applications
- ✓ Light weight tripod with T&E
- ✓ Full ballistic solution Target Acquisition Fire Control
- Ring mount and pedestal mount compatible
- ✓ Converts to .50cal XM312

#### ROV

- ✓ Integrated weapon, feed, sensors, and actuators
- Reduced integration effort, and weight and volume impact to vehicles.
- Remote safe, charge, and fire, self-powered
- ✓ Dual feed, first round selectable





### XM307 ACSW

### Readily Supports Platform Integration







- ✓ Light Weight, Low Recoil, and Self-Powered, Minimizes Platform SWaP Requirements
- ✓ Rapid Dismount Capable
- ✓ Dual Feed Capable
- ✓ Lethal 25mm Munitions
  - ➤ Air Burst Defeats Defilade Targets to 2,000m
  - ➤ Suppress and Defeat Area Targets to 2,000m
  - ➤ Armor Piercing Defeats Light Armor
- ✓ Remote Operations Capable
- ✓ Day/Night/All Weather Capable

### **Unmatched Lethality with a Light Machine Gun Package!**

### XM307 / XM312 Weapon System 25mm & .50cal

- ✓ Operator level change from 25mm XM307 to .50 cal XM312
  - ➤ Four part interchange
  - ➤ No special tools
- ✓ Fires standard .50 cal ammunition
- ✓ Lower recoil, lighter weight, and higher accuracy than legacy weapons







### XM312





Lightweight and flexible design to defeat variable threats

### XM307 / XM312 Mobility

### Portability for Dismounted Operations







System	40mm Mk-19 Mod3	Cal .50 M2HB	25mm XM307
Weapon Weight (lb)	75.6	84.0	30.0
Tripod Weight (lb)	65.4	46.1	18.8*
Fire Control (lb)	N/A	N/A	6.5
Unloaded System Weight (lb)	141.0	130.1	55.3
Peak Recoil (lbs)	800	1000	250

<sup>\*</sup> includes Pintle/T&E

- **✓** Quickly dismounts from vehicle
  - ➤ Supports Close Combat Fight
- ✓ Light & compact
  - ➤ Portable over rough terrain
  - >75-85 lb weight savings for most platforms

### **Enhances Close Combat Employment Flexibility**

### XM307 FCS Vehicle Integration **Common Weapon, Common Solution**

The XM307 has been selected as the Common Close Support Weapon for the Future Combat System Program

### >FCS Manned Ground Vehicles





### >FCS Unmanned Ground Vehicles



ARV-A(L) **Primary Armament** 



**ARV-RSTA Primary Armament** 

### **XM307 Platform Integration**

### **Vehicles & Mounts**

### **CROWS Mount**

- ✓ Accomplished 3Q02
  - ➤ Sponsored by JSSAP Office and TACOM-ARDEC
  - ➤ GDATP XM307 Weapon System Integrator
  - ➤ Raytheon Fire Control System
  - ➤ Recon Optical, Inc. CROWS Lightning Mount
- ✓ Successful integration & testing
  - > Remotely operated weapon/mount system
  - > Target, aim, and fire 25mm ammunition

### XUV

- ✓ Accomplished 1Q03
  - ➤ Sponsored by JSSAP Office and TACOM-ARDEC
  - ➤ GDATP XM307 Weapon System Integrator
  - ➤ Raytheon Fire Control System
  - > Recon Optical, Inc. CROWS Lightning Mount
  - >GDRS Experimental Unmanned Vehicle
- ✓ Successful integration & demonstration
  - > Remotely operated weapon/mount/vehicle system
  - ➤ Target, aim, and fire 25mm ammunition





## XM307 Platform Integration

### Stryker Remote Weapon Station

#### ✓ Phase 1

- Accomplished 4Q04
- XM312, .50cal, integrated onto Kongsberg Block 1 RWS
- Successful Integration, Operation, Targeting, & Firing

#### ✓ Phase 2

- Accomplished 3Q05
- XM307, 25mm, Integrated onto Kongsberg Block 2 RWS
- Successful Integration, Operation, Targeting, Firing, and Air-Bursting of 25mm rounds
- Dispersion 70% of XM307 SDD Exit Criteria





### XM307 Platform Integration

### Phase 3 Integration & Stryker Demonstration

- ✓ Joint Industry / Government initiative
- ✓Integration and testing at RTTC
- **✓** May 11, 2006 Demonstration of system capability, lethality, and portability
  - ➤Integrated XM307 / RWS / Stryker System
  - >25mm TP & TP-S rounds
    - Static vehicle live fire
    - Moving vehicle live fire
  - >.50cal Ball & Tracer rounds
    - Static vehicle live fire
    - Moving vehicle live fire
    - Moving vehicle / moving target live fire
  - Dismounted firing
    - 25mm & .50cal





## **Summary**

- **✓** Demonstrated capability with multiple platforms
- **✓** HEAB, AP, and .50 cal provides a lethality overmatch
- ✓ Light weight and low recoil facilitates integration









# PLASMA TRANSFER ARC FABRICATION OF ENHANCED PERFORMANCE BARRELS

### NSAC/NSATC ARMY CONTRACT W15QKN-05-9-0200 -0007 ANTIMATERIEL SNIPER RIFLE BARREL

Program Manager: Neil Lee

### NDIA JOINT SERVICES SMALL ARMS SYMPOSIUM

May 16, 2006

#### **MER Corporation**

7960 S. Kolb Road Tucson, AZ (520) 574-1980 Fax (520) 574-1983 E-mail kchristou@mercorp.com www.mercorp.com



### PRESENTATION OUTLINE

- □ Weapon System Enhancement Requirements
- Solution Approach
- Enabling Technology Plasma Transfer Arc(PTA)
- □ Prior PTA Barrel Work
- □ 50-Cal Antimateriel Sniper Rifle barrel Work
- Technology Future Potential



### WEAPON SYSTEM ENHANCEMENT REQUIREMENTS

- Ease of portability
  - Lighter Weight
- Long effective range
  - Hotter propellants
- Accuracy (one-shot-one-kill)
  - Barrel Structural Integrity (Reduced Flexure)



### **SOLUTION APPROACH**

- Fabricate a composite barrel
  - liner + over-wrap
- □ Grade the component materials functionally
  - Erosion resistant refractory metal (Mo-Re or Ta- W alloys)
  - Or monolithic ceramic (SiAlON) liner.
    - Hotter propellant requirement
  - Light weight metal (Ti) over-wrap
    - □ Light weight requirement



## **SOLUTION APPROACH (CONT'D)**

- □ Create a continuous interface between the two components
  - Eliminates thermal impedance
    - ☐ Thermal management hotter propellant requirement
  - Provides a continuous and symmetric load transmission
    - □ Structural integrity reduced flexural deflection accuracy requirement



## **SOLUTION APPROACH (CONT'D)**

- Maintain the liner in compression
  - Functionally equivalent to autofrettage
  - Counteracts the propellant gas pressure to reduce stress in the liner
    - □ Counteracts the mechanical stress component of erosion/wear
    - Erosion/wear resistance hotter propellant requirement
  - Reduces stress on the over-wrap for better barrel structural integrity
    - □ Structural integrity improvement accuracy requirement

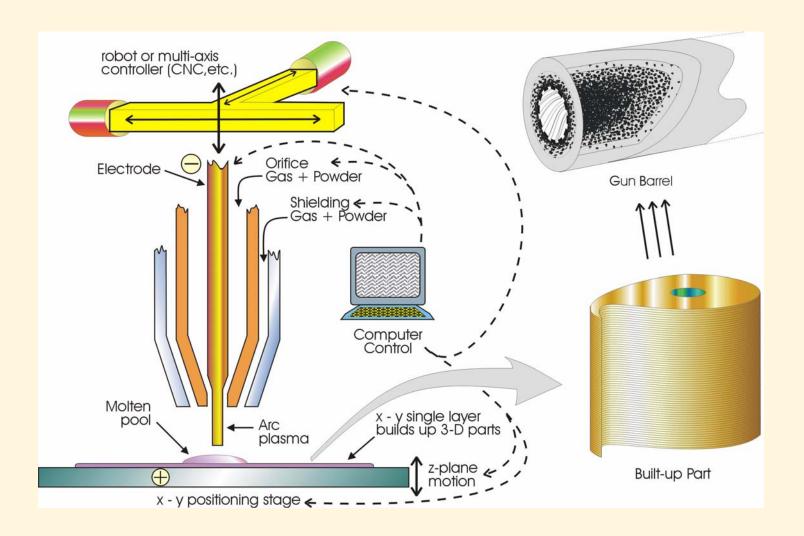


## **ENABLING TECHNOLOGY - (PTA)**

- Melts and deposits any metal selectively to form a near net shape feature
- Both liner and over-wrap can be formed
- □ Current barrel work is limited to depositing the over-wrap over an existing refractory metal or ceramic liner
- As the over-wrap metal cools down, it forces the liner into a tri-axial state of compression
- The interface between the liner and the over-wrap is continuous
  - Metallurgical bond for refractory metal
  - Perfect overlay for ceramic

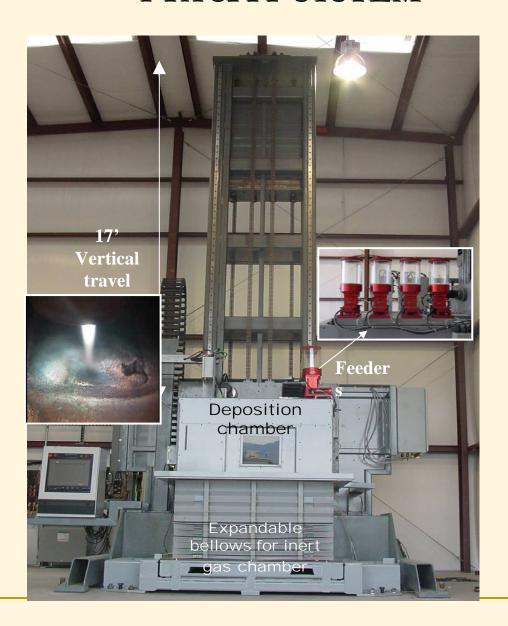


### **PTA SCHEMATIC**



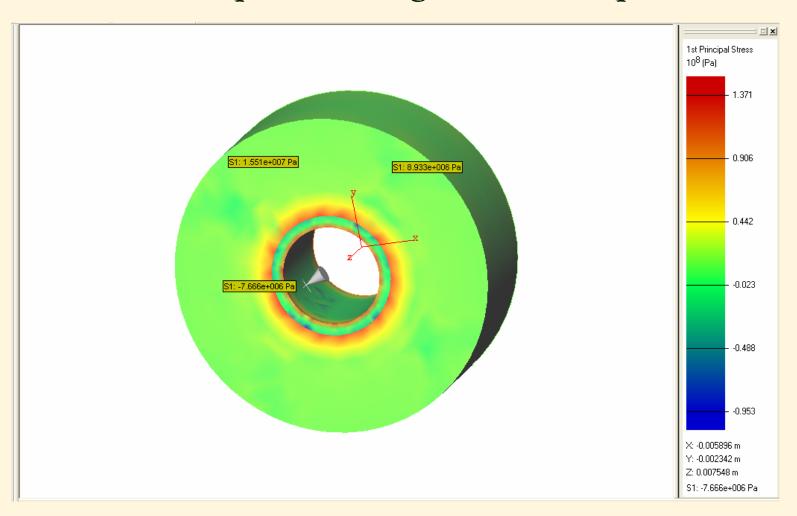


## **PTA SFFF SYSTEM**



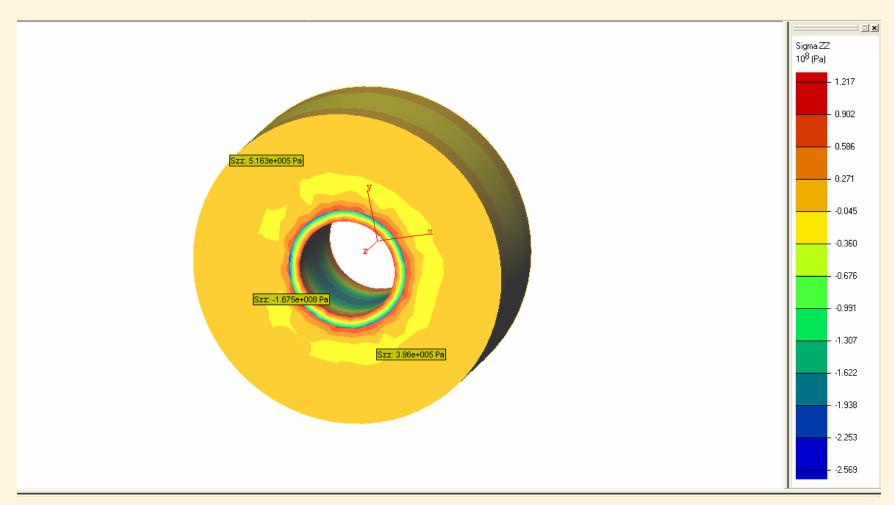


# 50 CAL Mo-Re LINER WITH PTA Ti OVER-WRAP Liner is in Compression- Negative 1st Principal Stress



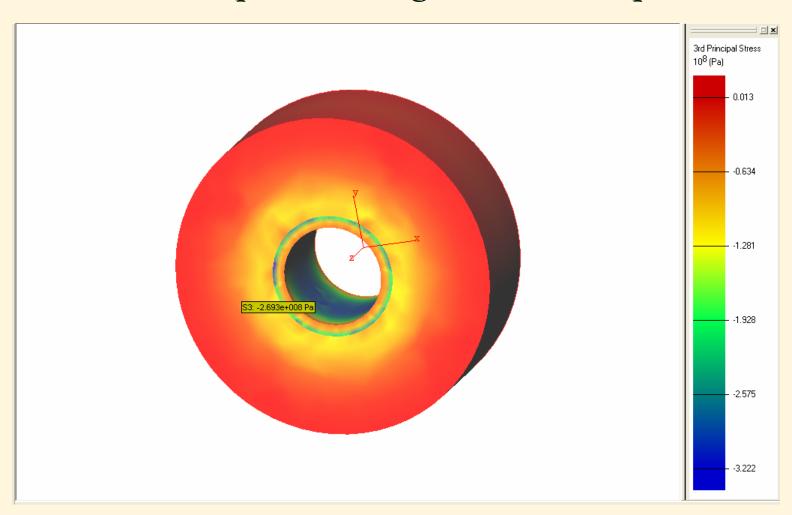


# 50 CAL Mo-Re LINER WITH PTA Ti OVER-WRAP Liner in Compression- Negative $\sigma_{zz}$ Stress





# 50 CAL Mo-Re LINER WITH PTA Ti OVER-WRAP Liner in Compression- Negative 3rd Principal Stress





# PRIOR WORK (M249 BARREL)

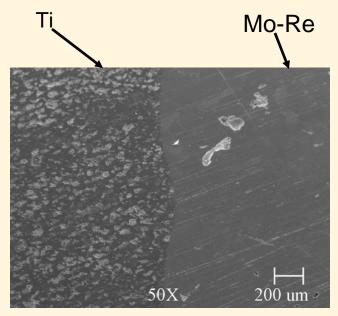
- M249 with Mo-47.5Re liner and PTA titanium over-wrap
  - SEM images show a continuous interface between liner and over-wrap
  - Tested to about 1800 rounds using 50, 100, and 200 bursts
  - Numerous stoppages due to poor surface finish on the chamber
  - No signs of cook-off at 200 round burst
  - Barrel OD temperature comparable to that of a standard M249 barrel.



# M249 REFRACTORY METAL LINER (Mo-Re) WITH PTA Ti OVER-WRAP

## As-produced



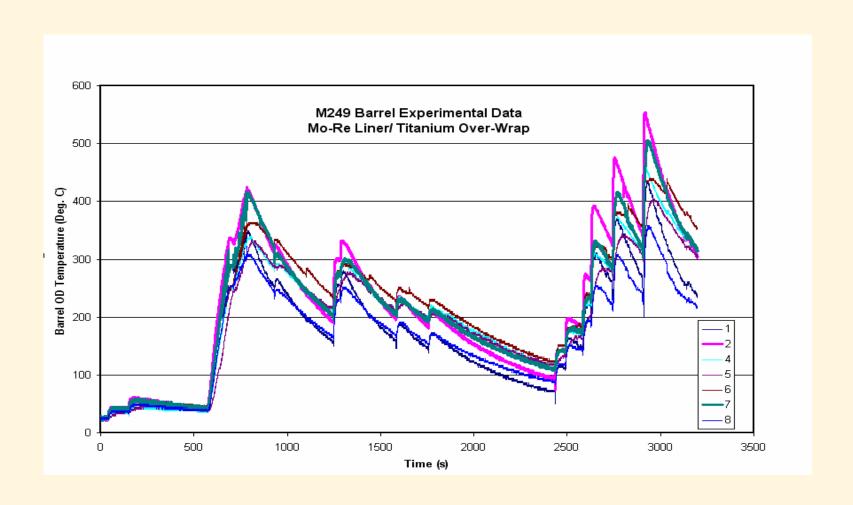


## After machining OD





### **M249 BARREL LIVE - FIRE TESTING**





# 50-CAL ANTIMATERIEL SNIPER RIFLE BARREL WORK CERAMIC LINER VERSION

- Monolithic Ceramic (SiAlON) Liner
  - In-situ rifling proved feasibility in another project
- □ PTA Ti over-wrap
  - Proved feasibility in depositing titanium without cracking the ceramic
  - Titanium low thermal conductivity may not be a great issue in a sniper rifle



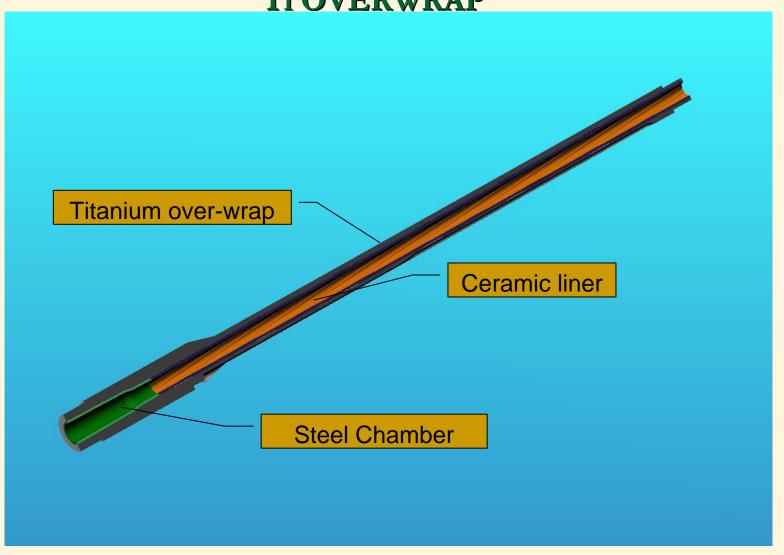
# 50-CAL MONOLITHIC CERAMIC LINER WITH PTA Ti OVERWRAP

# SiAION 50-Cal liner before and after PTA over-wrap





# MONOLITHIC CERAMIC LINER WITH PTA Ti OVERWRAP





# 50-CAL ANTIMATERIEL SNIPER RIFLE BARREL WORK REFRACTORY METAL LINER VERSION

- □ Ta-10W or Mo-47.5Re Liner
  - Mo-47.5Re can be rifled routinely with ECM
  - Ta-10W may be rifled with single point rifling
- □ PTA Ti over-wrap
  - PTA titanium does not affect features in the Ta-10W bore
  - Liner is in compression by virtue of the PTA process
  - Titanium low thermal conductivity may not be a great issue in a sniper rifle

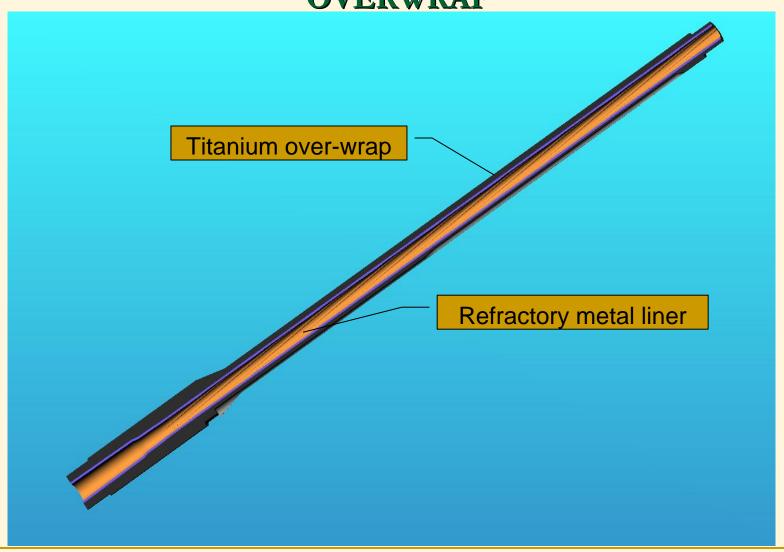


## FORMED REFRACTORY METAL LINER





# REFRACTORY METAL LINER WITH PTA Ti OVERWRAP





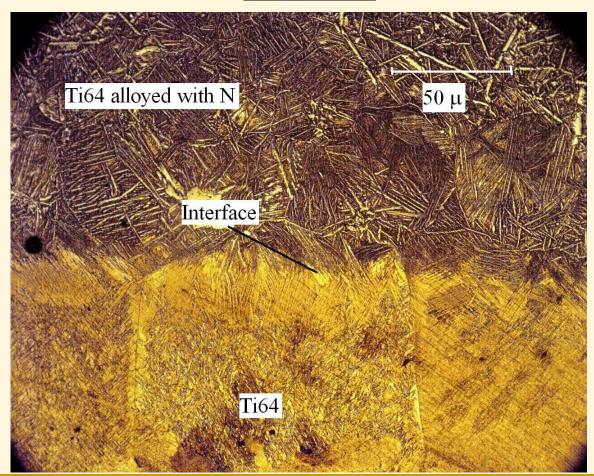
### **TECHNOLOGY FUTURE POTENTIAL**

- □ Form the entire barrel (titanium) over a mandrel to generate in-situ rifling
- Form a ceramic (titanium nitride) layer on the bore of a titanium barrel which grades continuously into the titanium barrel body.
- Generate a lubricious Ti-N alloy layer at the bore
- □ Titanium low thermal conductivity may not be a great issue in a sniper rifle



# TECHNOLOGY FUTURE POTENTIAL (CONT'D)

#### <u>Ti-N Alloy Lubricious Layer Functionally Graded</u> <u>with a Ti64 Part</u>









# PM Individual Weapons Overview

# **Small Arms Symposium**

15-18 May 2006



**PM Individual Weapons** 

LTC Tim Chyma
Product Manager Individual Weapons
(973) 724-4695
tchyma@pica.army.mil



# **Individual Weapons**







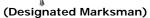
# Family of Weapons Variants & Lethality Modules





















# XM25 Air Burst Weapon System



#### **DESCRIPTION**

A semi-automatic rifle with an integrated target acquisition fire control that fires 25mm air bursting munitions.

**ACQ STRAT:** Developmental

**QTY: TBD** 

**PHASE:** Technology Development

**CONTRACTOR:** Alliant Techsystems, Plymouth, MN; L3 Communications (Brashears), Pittsburgh, PA; H&K,

Oberndorf, GM

#### **CAPABILITIES**

- Defeats defilade targets
- Family of 25mm ammunition (includes HEAB, TP, AP, non-lethal)
- 500 meter point targets
- 500-700 meters area targets
- Fully integrated target acquisition/fire control

(2x Thermal, 2x DVO, LRF, compass, fuze setter, ballistic processor, and internal display)



- Design Refinement (system weight reduction, fuze, TA/FCS interface)
- Engineering testing



# XM26 Modular Accessory Shotgun System (MASS)



#### **DESCRIPTION**

A lightweight accessory shotgun system that attaches under the barrel of the M4 and M16 Modular Weapon Systems.

**ACQ STRAT: COTS/NDI** 

QTY: Tentatively 26,789

PHASE: Systems Dev & Dem

**CONTRACTOR:** Vertu Corp

#### **CAPABILITIES**

- Fires Lethal, Non-lethal and Door Breaching 12 Ga. Rounds
- Can be zeroed to the sighting system of the host weapon
- Lethality equivalent of a stand-alone
   12 Ga. Shotgun
- · Can be fired as a stand-alone weapon

- Developmental Testing
- Operational Testing
- Production Decision
- Fielding

# XM320 GRENADE LAUNCHER MODULE (GLM)

#### DESCRIPTION

A 40mm grenade-launching weapon module that will replace M203 series grenade launchers currently mounted on the M16/M4 series of rifles and carbines.

**ACQ STRAT: COTS/NDI** 

QTY: Tentatively 71,600

PHASE: Systems Dev & Dem

**CONTRACTOR:** Heckler & Koch Defense Inc.

#### **CAPABILITIES**

- Integral Day/Night sighting system improves target acquisition and accuracy
- Improved Reliability and Safety
- Can be fired as a stand-alone weapon
- Unrestricted breach allows a wider array of munitions





- Operational Testing
- Production Decision
- Fielding





# Family Of Small Arms Suppressors (FoSAS)

#### DESCRIPTION

A family of accessory suppressors that attach to the muzzle of the weapon to reduce the firing signature.

**ACQ STRAT:** COTS/NDI (Small Business Set Aside)

**QTY:** Tentatively 78,270 (35,770-M9; 40,000-M4/M16;

2,500 M249)

PHASE: Downselect (M9 & M4/M16)

**CONTRACTOR: TBD** 

#### **CAPABILITIES**

- Reduces muzzle flash, noise, smoke and dust
- Family that attaches to M9, M4/M16 and M249
- Easily installed by operator
- No adverse effects on weapon reliability or performance





- Final Proposal Evaluations
- Contract Award
- Deliver Test Samples
- Begin Developmental Testing



# XM150 Rifle Combat Optic (RCO)



#### DESCRIPTION

A magnified optic that attaches to M4s, M16s and M249s to improve the ability to recognize and engage targets out to 600m.

**ACQ STRAT: COTS/NDI** 

QTY: Tentatively 135,091

PHASE: Pre Solicitation

**CONTRACTOR**: TBD

#### **CAPABILITIES**

- Improved capability to recognize and engage targets 0-600m.
- Allow Soldier to rapidly transition between close quarter and long-range engagements.

- Requirement Approval
- Solicitation Release
- Full & Open Competition
- Contract Award



# Emerging Requirements/Programs



### **Emerging Requirements**

- Handgun/Pistol
- Personal Defense Weapon
- Family of Weapons

### **Expected Acquisition Approach**

- COTS/NDI
- Full and Open Competition





# Joint Service Small Arms Synchronization Team (JSSAST) Update

Joint Services Small Systems Section
Annual Symposium, Exhibition and Firing Demonstration

16 May 06

Presented By

**COL Scott Crizer JSSAST Chairman** 



# JSSAST Update



# Agenda

- JSSAST Mission
- **▲ JSSAST Membership**
- **△ Chairman's Overarching Themes**
- **▲ JSSAP Tech Base Planning**
- Summary













## Joint Service Small Arms Program Office (JSSAP)



#### ▲ Who

Joint Service Office Located Within the Army Armaments **Research Development and Engineering Center** 

#### Mission

- > Establish Joint Requirements
- → Evolve Technology for New Soldier Weapon Systems
- → Manage and Execute the Technology Base

### Funding

- → Annual Funding at \$10-12M Over the Last Decade
- → Congress has historically added approx \$5-6M per year
- Funding Only Supports One Major Effort
  - -Currently Addressing Lightweight Small Arms Technologies

#### **Members**













Charter Updated and Approved
by ASA (ALT) Hon Claude Bolton
31 Aug 04





# Joint Service Small Arms Synchronization Team (JSSAST)



Meets Semiannually

### Chairman

COL Scott Crizer (Commander, ASIC)

### **Principals:**

Army: COL R. Radcliffe (USAIC)

Marines: LtCol R. Adams (MCSC)

Air Force: Col C. Beck (HQ AFSFC)

Navy: CAPT R. Ruehlin (PEO LMW)

Coast Guard: CAPT(S) A. Davenport (HQ USCG)

SOCOM: COL K. Noonan (HQ SOCOM)

Associates:

**Army PMSW:** COL C. Lipsit (PEO Soldier)

JNLWD: Mr. K. Swenson (JNLWD)



## **JSSAST**



# Chairman's Overarching Themes

- **▲ Better Synchronization of Service Small Arms Activities**
- Greater Awareness of JSSAP's Work
- ▲ More Funding for Small Arms Science and Technology



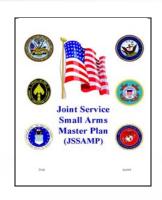
# Joint Service Small Arms Technology Base Planning Process



### The Foundations

- A Joint Service Small Arms Master Plan

  Provides an Azimuth for the Future
- ▲ A Joint Small Arms Capability Assessment Identifies Capability Gaps
- National Small Arms Center
  Provides Industry <u>Technology Assessment</u>









# Development of Technology Plan











### **JSSAP Technology Investment Plan**

- Technical Fire Control
- Tactical Fire Control
- New Concepts & Applications
- Smart Munitions
- Warheads & Energetics
- Lethality & Utility
- Materials & Processes
- Modeling & Analysis

Technology Needs Far Exceed Available JSSAP Funding



# **Technology Plan Development**



### What's Next?

- Prioritize Technology Thrusts
- Develop Potential Work Packages
- Execute with Available JSSAP Funding

\$17+ Million Increase over the POM Achieved



# JSSAST Update



## Summary

- **△ Joint Small Arms Capabilities Assessment Completed**
- ▲ Campaign to Increase JSSAP Tech Base Funding <u>Successful</u>
- Prioritization of Tech Area Thrusts Progressing
- Campaign for Greater Awareness of JSSAP Continuing



# Office of Counterterrorism & Special Missions





# Joint Service Small Arms Systems Annual Symposium 16 May 2006

Commander Aaron Davenport Commandant (G-RPC-1) Coast Guard Headquarters





## **Overview**



- ► Location & Organization
- > Handgun Replacement Project
- Disabling Fire Weapon
- >Urgent Requirements



# **Location & Organization**



#### > Location.

Commandant (G-RPC-1)
Coast Guard Headquarters
2100 2<sup>nd</sup> Street SW, Room 3406
Washington, DC 20593

Phone: (202) 267-0164

#### Organization.

- Office of Counterterrorism & Special Missions.
  - Member of the Joint Service Small Arms Program (JSSAP).
- Organization Staffing.
  - Captain Stephen Austin (Office Chief).
  - Commander Aaron Davenport (Division Chief).
  - Lieutenant John Strasburg (Small Arms Program Manager).
- Liaison Positions.
  - Small Arms Repair Facility at NSWC Crane, Indiana.
  - Liaison to the Naval Operational Logistics Support Center (NOLSC) Mechanicsburg, Pennsylvania.



# Handgun Replacement Project



- > SIGARMS P229R-DAK is Replacing the M9 Beretta.
  - Officially began 07 Oct 05.
    - Sector Delaware Bay was the first unit to completely transition.
    - Well received by the field.
- ➤ Type classification NSWC Crane Division.
  - .40 caliber (frangible, JHP, & Ball).
  - 5 year Indefinite
    Delivery/Indefinite Quantity
    (IDIQ) contract anticipated.





# **Disabling Fire Weapon**



- > Transition from a Bolt Action to a Semi-Auto Rifle.
  - RC-50 Robar Is CG's current DFW.
  - M107 Barrett potential.
- ➤ M107 is being Operationally Tested and Evaluated, because it meets many of the internally derived requirements.
- > Non-operational training & evaluation with M107 was satisfactory.
- > Green light to employ "limited" operational.





# **Urgent Requirements**



- > 7.62mm lethal ammunition with a reduced range for use in constricted waterways.
- > "Flash bang" type device used in potentially explosive environment (intrinsically safe).



# **Coast Guard Small Arms**





M14 T (Tactical)



P229R-DAK



M4



M107





# Joint Small Arms Capability Assessment Analytical Procedure

2006 National Defense Industrial Association's Joint Services Small Arms Systems Annual Symposium

John Edwards May 16, 2006



# **Presentation Outline**



## 1. JCIDS to JSACA

(<u>Joint Capabilities Integration and Development System</u> to <u>Joint Small Arms Capabilities Analysis</u>)

# 2. Analysis Description for:

- a. Functional Area Analysis
- b. Functional Needs Analysis
- c. Functional Solution Analysis
- 3. JSACA Deliverables
- 4. JSACA Conclusions
- 5. JSACA Summary



# Joint Service Small Arms Capability Assessment



#### Background:

- Capabilities Assessment by the JSSAP Application Working Group (AWG) to support the Joint and Individual Service Requirements Generation Process.
- Sponsored by the Joint Service Small Arms Synchronization Team

• Follows the guidelines, as appropriate, of:

Chairman of the Joint Chiefs of Staff Instruction – CJCSI 3170.01 E (11 May 2005)

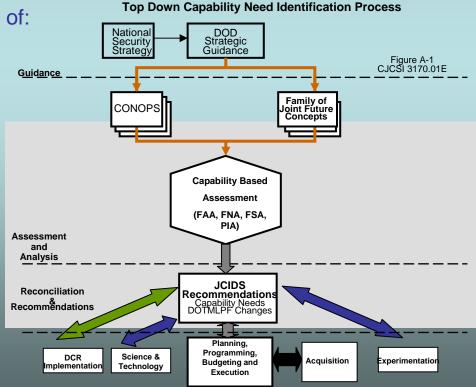
Chairman of the Joint Chiefs of Staff Manual -

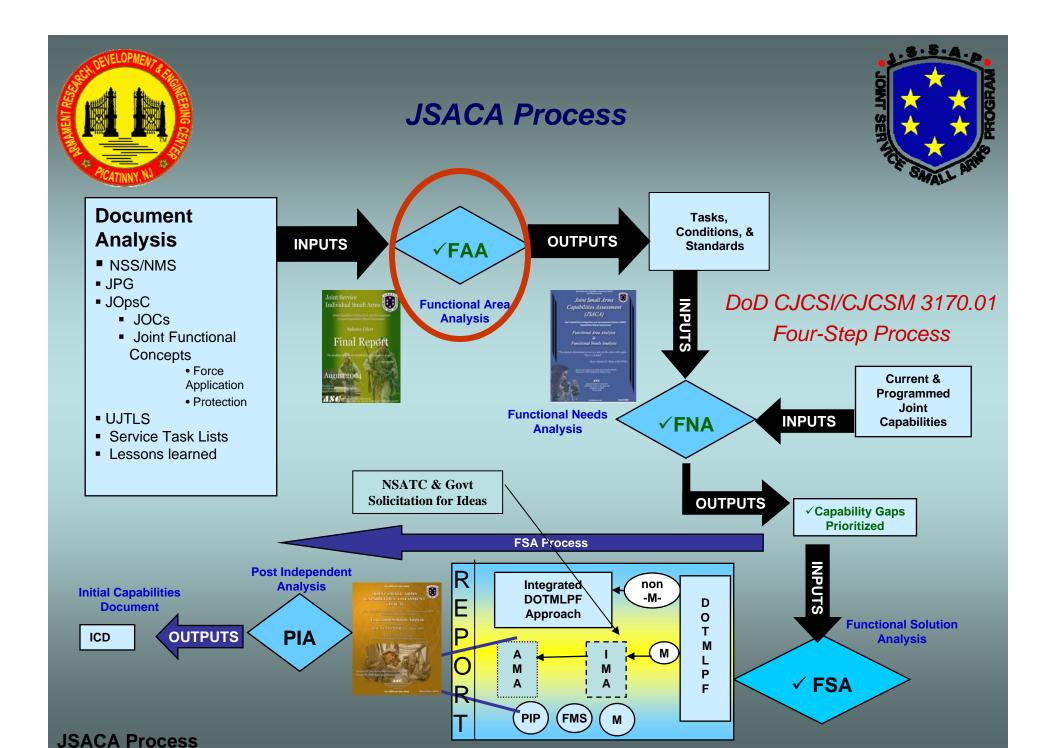
CJCSM 3170.01 B (11 May 2005)

#### **JSSAP MISSION:**

HARMONIZE REQUIREMENTS ACROSS
SERVICES

1978 OSD, review 2004 Army AAE







# Function Area Analysis



#### - INPUTS

- Universal Joint Task Listing
- Service (unique) Task Listing
- Lessons Learned

# ➤ Analysis Tools

- ✓ Tasks provide an Activity Network structure
- ✓ Multi-Voting/Pareto technique by SME JSSAP AWG



# JSACA Content Format From Functional Area Analysis



**US Army** 

**US Marine Corps** 

**US Navy** 

**US Air Force** 

**US Coast Guard** 

SOCOM

7 Tasks of 27 Sub Tasks of 72 Gap Metrics

- Transmit & Receive
- Neutralize
- Suppress
- Breach
- Personal Defense
- Avoid Detection
- Tag & Mark

Far Term

Mid Term

Near Term

Each survey respondent weights the relative importance of three Time Frames (Near, Mid and Far Term)



#### JSACA Process



# Document Analysis

- NSS/NMS
- JPG
- JOpsC
  - JOCs
  - Joint Functional Concepts
    - Force Application
    - Protection

**OUTPUTS** 

UJTLS

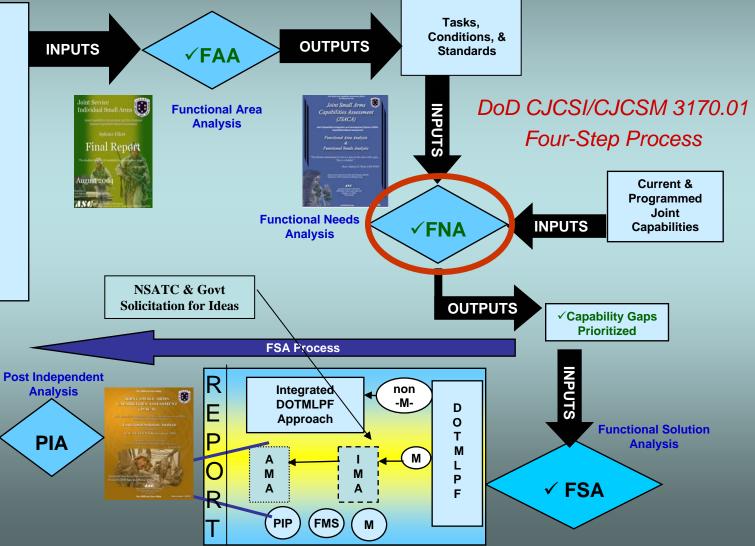
**Initial Capabilities** 

**Document** 

**JSACA Process** 

ICD

- Service Task Lists
- Lessons learned

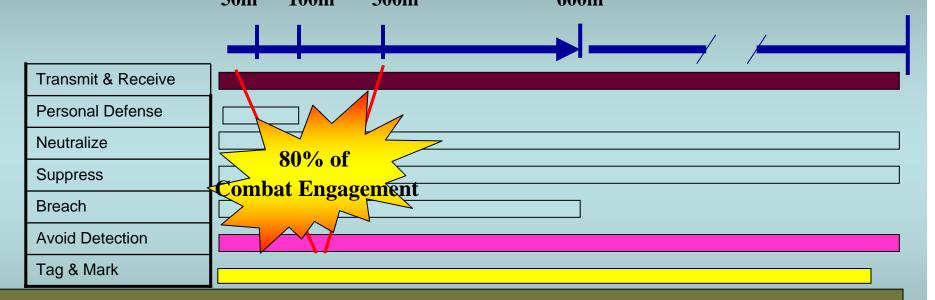




# **Function Needs Analysis Inputs**



The Gaps in Context; Battlespace Depth—Task Comparison



#### Conditions

- Universal... e.g., day, night, all-weather
- Shooter / Target Posture... from defilade
- Battlespace Depth: *CQB 0-50m*;

Close 0-100m; Mid 50-600m; Far 300-3000m

#### Standards

- Respects 3 time periods
- —near-, mid-, and far-term
- Graduated probabilities—
- e.g., Probability of 50%, 70% and 100%



# **Function Needs Analysis**



- Analysis Tool Check Sheet
  - Comparison of Task-Subtask/Timeframe
    - Current Capability
    - Defined Capability

#### **NO GAP Exists**

- When Current Capability > Defined Capability
   GAP Exists
- When Current Capability < Defined Capability</li>



# JSACA Gap Priority Survey Review



#### How

- Gap Prioritization via JSSAP Application Working Group Survey over web
- 21 total participants
   (13 Army, 4 USMC, 1 ea USN, USAF, USCG & SOCOM)
- Survey methods
  - Multi Criteria Decision Analysis (MCDA) via pair-wise rating (Analytical Hierarchy Process)
  - Ad Hoc value rating (9 highest)



# Functional Needs Analysis Gap Priority Techniques



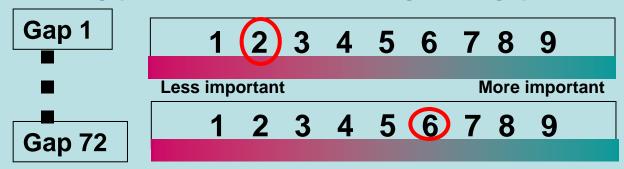
- MCDA Multi Criteria Decision Analysis
  - Pair wise comparisons in an Analytical Hierarchy Process
  - The importance of one Task is compared relative to the importance of another
  - Scored numerically (example below)

**Transmit & Receive Data** 

**Neutralize Target** 

	9	8	7	6	5	4	3	2	2	2 3 4 5 6 7 8 9
More important Equal							Ε		More important	

- Ad Hoc rating
  - No filtered hierarchy
  - Each gap evaluated on its own merit "gut-feeling" prioritization





#### JSACA Process



# Document Analysis

- NSS/NMS
- JPG
- JOpsC
  - JOCs
  - Joint Functional Concepts
    - Force Application
    - Protection

**OUTPUTS** 

UJTLS

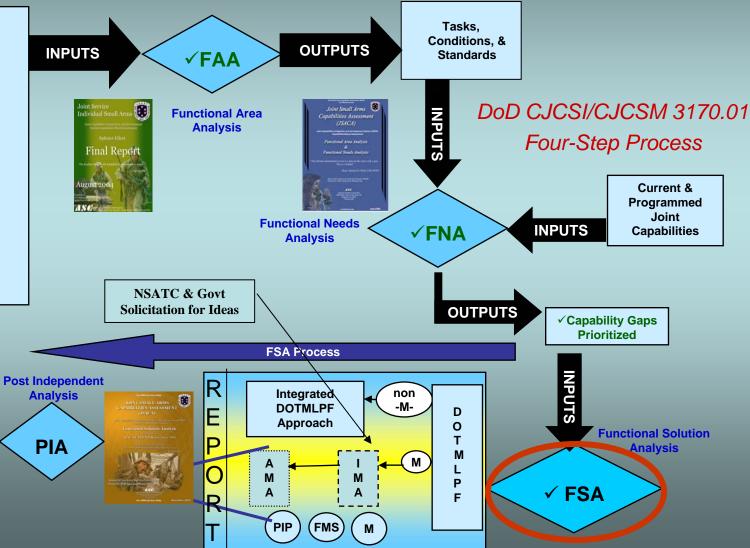
**Initial Capabilities** 

**Document** 

**JSACA Process** 

ICD

- Service Task Lists
- Lessons learned





# Analysis of Materiel Approaches General Rules



- Materiel Approaches pre-mapped and readjusted per AWG.
- Analysis Context
  - In relation to Gap Metrics (72 Gap Metrics)
  - Timeframe
  - JCIDS criteria
    - % of attainment of Gap
    - Technical Maturity (TRL)
    - Technical Risk

- Supportability (adapted per survivability)
- Affordability
- Operational Risk
- DOTLPF impacts
- FSA is an operationally based assessment of all potential DOTMLPF and policy approaches
- For IMA do not describe specific systems for use, rather desired capability, i.e. "UAV with a bomb".



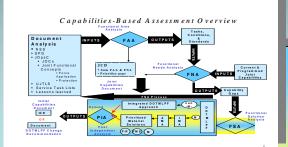
# Analysis of Materiel Approaches



Pool of 65 Ideas



Cap Gap
Prioritization
& Metrics



#### **Analysis of Materiel Approaches**

**Respect Prioritization of the Cap Gap Categories** 

**Examine Ideas Relevant to Prioritized Cap Gap Categories** 

**SUB-STEP ONE--ASSESSMENT** 

**Operational Worth: Mitigation Worth and Operational Suitability** 

Programmatic Worth: Tech Risk, Tech Maturity, Supportability, Affordability

**SUB-STEP TWO--ANALYSIS** 

**Operational Worth and then Programmatic Worth** 

**Comparative Analysis of Approaches** 

**Results Presentation** 

14 More Ideas
For Consideration

Approaches
Of Clear Merit

Approaches
Of Significant Merit

Capability Gap Categories
With No Apparent Approaches

Analysis of Materiel Approaches Review



# JSACA <u>Change Recommendations</u>



#### **Deliverables**

- •Establishes Joint Capability Requirements
- Opportunities/Basis for Support for the following;
  - Doctrine Change Requirement
  - •Initial Capabilities Documents
  - Critical Capabilities Document
  - Critical Production Document

Further focus on Ideas that effect Functional Characteristics Durability / Reliability / Weight/ etc.

Provides reference to S&T investment via
 Evolve Technology for New Soldier Weapon Systems
 Manage and Execute the Technology Base
 DTOs (Defense Technology Objectives)
 ATOs Army Technology Objectives

Consider Ideas with Potential for Increased Lethality High Risk, really S&T ventures



# **JSACA Conclusions**



- 1. A Joint Service Harmonized document
- 2. "Guide" to Capabilities the Services desire in the future.
- 3. Defines gaps for technology base and supports acquisition activities
- 4. Requires updating periodically

#### <u>Overall Recommendation – Next Step</u>

Staffing by executive agent – Army
Coincident Review by All Services for Joint awareness at
Functional Control Board



# JSACA Summary



## JSSAP-sponsored Analysis:

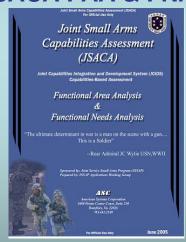
Conducted in accordance with CJCS JCIDS guidance

## **Products**

#### **JSISA Splinter Effort**



#### **JSACA FAA & FNA**



#### **JSACA FSA**



## The Benefits:

Form the Basis for Future requirements

**Details where investment is needed** 

Recommendations/Conclusion





# PM Crew Served Weapons Overview for the Small Arms Symposium & Exhibition National Defense Industrial Association

16-19 May 2006

BG James R. Moran Program Executive Officer Soldier COL Carl A. Lipsit PM Soldier Weapons Mr. Peter Errante
Deputy PM Crew Served Weapons



# **Crew Served Weapons**



















# PM Soldier Weapons Programs List



#### **DEVELOPMENT**

Objective Individual Combat Weapon (OICW)

1//	FΛ	DO	NS
		rv	113

#### *37.* M101, CROWS, Remote Mount **OICW Increment I** 1. 38. M151E1 & M151E2 Protector Remote Wpn System (RWS) 2. OICW Increment II - XM25 Air Burst Weapon 39. **MK19** 40. **Mod Kit** Advanced Crew Served Weapons (ACSW) Lightweight Adjustable Sight Bracket 41. Advanced Crew Served Weapon (ACSW) Programs 3. 42. Tactical Engagement Simulator (TES) SOLDIER ENHANCEMENT PROGRAMS 43. M107 Semi Automatic Long Range Sniper Rifle M240B, 7.62mm Medium MG XM26 - 12 Gauge Modular Accessory Shotgun System 44. (MASS) 45. M240B Collapsible Buttstock M192, Light Weight Ground Mount For MG 5. **Joint Combat Pistol** 46. Improved Bipod Family of Small Arms Suppressors 47. 6. M68 Close Combat Optics (Dual Source Qualification) 48. Improved Flash Suppressor 7. XM1068, 12 Gauge Non-Lethal Extended Range Round 49. **Combat Ammunition Pack** 8. XM1022, Sniper Ammunition for M107 50. M240B Short Barrel 9. **10.** XM110 - 7.62 Semi-Automatic Sniper System (SASS) **51**. M240B Improved Buttstock Sling Assembly for the M240B 11. **Close Quarters Battle Kit** *52. 53*. 12. XM1041/XM1042/XM1071 - Close Combat Mission Short Barrel Capability Kit 54. M249, 5.56mm Squad Automatic Weapon Advanced Sniper Accessory Kit (ASAK) *55.* M192, Lightweight Ground Mount For MG *13.* XM320 - Grenade Launcher Module (GLM) 56. MG Front Rails 14. *57.* Improved Bipod **BLOCK MOD PROGRAMS** *58.* Collapsible Buttstock *15.* **CROWS-Lightning Remote Weapons Station** *59.* Short Barrel for the M249 *16.* XM150, Magnified Combat Optic (MCO) 60. Slina Assembly For M249 *17.* Enhanced Cal .50 Machine Gun 61. M16A4 5.56mm Rifle 18. Platform Integrated Swing Arm Mount 62. M16 Rifle Mods 19. M240E6, Medium Machine Gun Weight Reduction Program 63. M4, 5.56mm Carbine 20. M240H, 7.62mm MG High Capacity Feed System 64. M4 Mods M249 SAW 200 Round Soft Pack 21. *65.* M145 Machine Gun Optics 66. M25 Stabilized Binoculars AMMO BLOCK MOD PROGRAMS 67. M24 Mini Binocular

- 22. XM1037, Short Range Training Round For M4, M16 and
- 23. **Lightweight Small Caliber Ammunition**
- **Proximity Fuze** 24.
- 25. 40mm Day Night Training Cartridge (FCT)

#### **RFI FY05 ITEMS**

26.	TA31F - 4X ACOG	Back Up Iron Sight
<b>27.</b>	Weapon Light	M249 Rail
28.	M24 Small Binoculars	M240B Rail
<i>29.</i>	M122/A1 Tripods	M249 Ammo Soft Pack
<i>30.</i>	M249/M240B Spare Barrel Bag	M240B Combat Ammo Pack
31.	Three Point Sling	M192 Lightweight Tripod
<i>32.</i>	Improved Spotting Scope With Tripod	M249 Short Barrel
33.	Improved Cleaning Kit	M249 Collapsible Buttstock
34.	Improved Buttstock For M4 Carbine	M4/M5 Modular Weapon System
<i>35.</i>	Forward Grip Bipod	M145 Machinegun Optic
36.	M203 Day/Night Sight	M68 Close Combat Optic

#### AMMO PRODUCTION PROGRAMS\*

**PROCUREMENT** 

M1001, 40mm Canister Round M100, Grenade Rifle Entry Munition (GREM) MK243 MOD 0 9mm Jacketed Hollow-Point M862 5.56mm Short Range Training Ammunition M1030 12 Gauge Breaching Round M973/M974, 7.62 Short Range Training Ammo M992 IR Illumination Cartridge

M903/M962 Cal .50 SLAP/SLAPT

**Programs Managed By PM Soldier Weapons** For PEO Ammunition In Accordance With MOA



#### **XM307**



#### **Description:**

• The XM307 Is A Lightweight 2-man Portable Crew Served Weapon Which Will Provide Enhanced Capabilities To The Soldier Improving Lethality And Survivability. This System Has Been Proposed By TSM Stryker As A Weapon System Capable Of Meeting Stryker Future Lethality Requirements For Mounted/Dismounted Operations.

#### Capabilities:

- Lightweight, 2-man Portable, Crew Served Weapon
- System With 25mm Air Bursting Munitions
- Subsystems Include:
  - Weapon
  - Target Acquisition/Fire Control (TA/FC)
  - 25mm High Explosive Air Bursting And Armor Piercing Ammunition
  - Lightweight Tripod

#### Status:

- SDD Contract Awarded
- Continue Development Of Dismounted Variant





# **Advanced Crew Served Weapon Firing**







#### XM307 Evolution



- XM307 ACSW originally developed for dismounted applications
  - Pre-STO (FY92-94)
  - STO (FY95-98)
  - ATD (FY99-04)
- FCS selected XM307 as the Common Close Support Weapon for 6 manned and 2 unmanned ground vehicles
  - SDD (FY04-Present)
  - XM312 developed as reliability growth tool
- FY05 FCS redirects program to develop XM307 as a Remotely Operated Variant (ROV), with integral Dual Feed and Remote Operations, including an Electronics Control Unit
  - XM307 ROV retains a common operating group with the ACSW, but dismounted capability removed



XM307 ROV



# XM307 / FCS Vehicle Integration Common Weapon, Common Solution



# The XM307 was selected as the Common Close Support Weapon for the Future Combat System Program









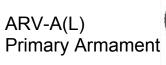






Secondary Armament

FCS Unmanned Ground Vehicles





ARV-RSTA
Primary Armament



# XM307 Remote Operating Variant (ROV) **Weapon System Concept**





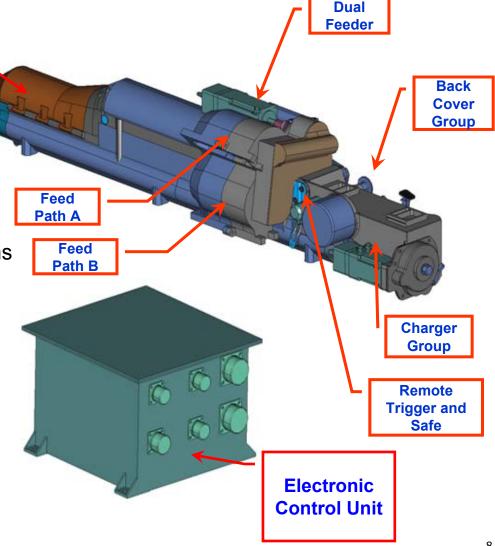
#### **Features:**

Optimized design for mounted applications

Integrated weapon, Feed, sensors, and **Actuators** 

Common interfaces for all FCS platforms

- Remote Operation
- Self-Powered Index
- HEAB Capable either path
- First Round Selectable
- +28VDC Input Power
- Weapon Length: 44.2 in, charged
- Weapon Weight: 50 lb estimate
- ECU Weight: 18 lb estimate

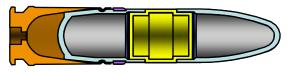




#### **ACSW Ammunition**



#### **HEAB Cartridge**



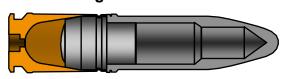
#### **AP Cartridge**



**TP-S Cartridge** 



**TP Cartridge** 



- HEAB Defeats Exposed and Defilade Targets
  - Precision Air-Bursting
  - PBXN5 High Explosive
  - Effective against PASGT Vest & Helmet
  - Controlled Fragmentation Warhead
- **AP** Defeats Light Armor
  - Armor Piercing Shaped Charge Round
  - 51mm RHA (Threshold) / 51mm HHA (Goal)

TP-S Flash Bang Training

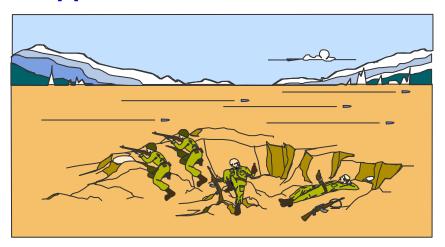
TP Simple Two-Piece Projectile for Training



# Air Bursting Munitions Increased Lethality for Infantry Warfighting



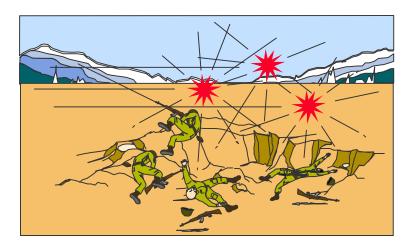
# **KE Ammunition Can Only Suppress Personnel In Defilade**



#### **Target Postures**

- Percent of the time
  - 5% Standing
  - 20% Gone to ground
  - 75% Gone to defilade

#### **Air Burst Ammunition Kills**



#### System Operation

- Laser range on target or near terrain
- Adjust aim point on target
- Fire
- Projectile air burst on target



# **Muzzle Velocity Correction**



Electronic Timed Fuzes Need Accurate Velocity Data To Burst On Target

Elocitorilo Timod I d200 1100d 7.00didio Volodity Bata To Barot off Targo



**Too Slow** 





- Muzzle velocity of packaged ammunition differs from round to round
- Fuze is updated with actual (individual projectile) velocity
- Ammunition Velocity Correction Yields Precision Air-Burst



# **Target Effects**







# SDD System Description (Ground Mounted)



#### **Muzzle Device**

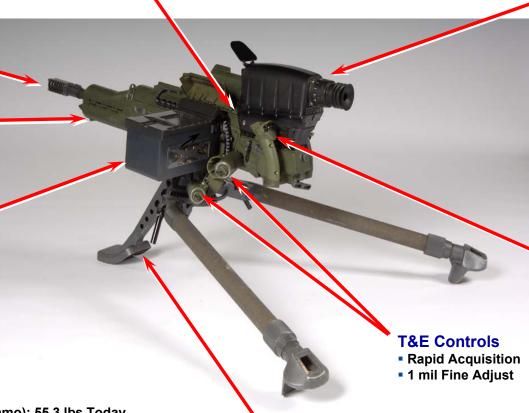
- Flash Suppression
- Inherently Reliable

#### Weapon -

- Light Weight, 30 lbs
- 25mm, 260 spm
- Soft Recoil
- Gas Operation

#### **Ammo Can**

- Right Or Left Mounted
- Linked Belt
- 31 Round Capacity
- All XM307 Ammo Types



**Fuze Setter Contacts** 

## Target Acquisition/Fire Control (TA/FC)

- Direct View Optics (DVO)
- Range Finder/CIDDS/MILES/Pointing Lasers
- CCD Video/FLIR/Tracker Module
- Full Solution Ballistic Calculation/Reticle Aimpoint
- Fuze Programming/Powers And Sets Fuze
- Digital Compass/Environmental Sensors
- 6.5 lbs w/o Thermal

#### **TA/FC Controls**

- Grip Mounted Switches
- TA/FC Rear Panel Switches
- Lase & Menu Select
- Increment/Decrement

System Weight (No Ammo): 55.3 lbs Today

- Range: 2000m
- Time Of Flight: 8.9 Sec. To 2000m
- Penetration Requirement (mm RHA): 51mm
- Stowed Kills (200rds): 27.9
- Integrated Full Solution Fire Control

#### **Ground Mount**

- Lightweight, 18.8 lbs w/ T&E, Pintle
- Stable Without Ballast
- Height Adjustable

#### **Land Warrior Interface**

- Lanyard Style "Breakaway" Connector
- Power, Data And Video Over Interface
- Compliant To LW Requirements



### **Target Acquisition Fire Control System**





#### **Characteristics/Component:**

- > 2.2 Km Performance (day only)
- Laser Rangefinder: ±1 meter Accuracy
- Thermal Sensors Interface (ISM)
- Direct View Optics 5x, 9.5° FOV
- Laser Steering (TA/FC#102)
- Digital compass
- Fire Control Ballistic Processor
- Motion Tracker (TA/FC#102)
- Land Warrior Ready
- Fuze Setter

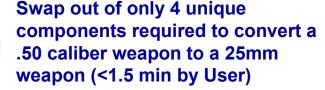
#### **TA/FC Features**

- Full Solution Fire Control
- High reliability: "100% Solid State"
- Reduced exposure to enemy
  - Reduced engagement time
  - Increased stand-off range
- · Simplified soldier training
- · Planned evolutionary growth
- Low power
- Low Weight
  - 6.5 lbs w/o Thermal
  - 8.6 lbs w/ External Thermal
- · 3 Systems Built to Support 2001 Government Testing
- · Demonstrated Over 3500 Live Rounds on Weapon
- 3 Systems Still In Use and Meeting Performance Requirement



## ACSW 25mm and .50 Caliber





- 1. Barrel
- 2. Bolt
- 3. Cartridge Guide
- 4. Sprocket



#### 2 Modern Weapons For Virtually the Cost Of One

- Low Recoil Reduces Vehicle Structural Mounting Requirements
- Lower Weight For Improved Transportability & Employment
- Lower Logistic Burden
  - Reduced Maintenance Due To Fewer Parts And Improved Design
  - Smaller Class IX Parts Inventory

- Operational Flexibility with Increased Lethality
- Low Cost Training Capability For The XM307
- Improved Safety & Reduced Maintenance Soldier Uses One System

XM312 = Commonality with XM307

# **Mobility**



## Heavy Firepower For The Close Combat Fight









System	40mm Mk-19 Mod3	Cal .50 M2HB	7.62mm M240	25mm XM307
Weapon Weight (lb)	75.6	84.0	24.2	28.0
Tripod Weight (lb)	65.4	46.1	19.2	13.0
Fire Control (lb)	N/A	N/A	N/A	6.5
Unloaded System Weight (lb)	141.0	130.1	43.4	47.5
Peak Recoil (lbs)	800	1000	80	250
Relative Lethality (lbs Ammo / Kill)	37	39	8	1

- Low Recoil Burden On Weapon Station
- Quickly Dismountable From Vehicle Platform
  - Portable Over Rough Terrain
- Light & Compact
  - 80-90 lb Weight Savings





# **Stryker Integration**



## Stryker Program Overview



- 7 Brigades funded by the U.S. Army
- Nearly 1000 vehicles built and delivered
- Over 300 vehicles deployed to Iraq
- Exceeding contract requirement for Operational Readiness Rate
  - Contractual ORR = 90%
  - Performance for 30 months deployed averages at 95.5%
- #1 Program Priority <u>INCREASED LETHALITY</u>



Reconnaissance (RSV) Mobile Gun System (MGS)



Medical Evacuation (MEV) Fire Support (FSV)



Anti-Tank Guided Missile (ATGM)



Mortar Carrier (MCV)



Infantry Carrier (ICV)



**Engineer Squad (ESV)** 



**NBC Reconnaissance (NBCRV)** 



Command (CV)



## M151 Protector Remote Weapon System



#### Weight:

Above the roof including (4) M6: 279 lbs (w/o M6: 245 lbs)

Total weight: 372 lbs (w/o M6: 338 lbs)

#### Supported Weapons:

MK19, M2, M240 (Deferred)
Growth To XM312/XM307, MK47 & Javelin

#### Sensor Suite:

Color 27X Day Sight
Dual FOV Night Sight (w/2x E-Zoom)
Auto Focus
STORM -Laser Range Finder
IR Pointer (low and high)
Visible Pointer
Low Ammo Sensor

#### Additional Features

- Stabilized
- Four-axis independent system Automatically corrects for super elevation and drift
- Embedded Training & Diagnostics







# ACSW/RWS/Stryker Integration Summary of Phases 1, 2, & 3



Phase 1: Conduct integration, testing, and demonstration of XM312 .50 cal on RWS at GDATPs Ethan Allen Firing Range (EAFR) – <u>Accomplished!!</u>



Phase 2: Conduct integration and testing of the 25mm XM307 ACSW on a (prototype stabilized) RWS system with hybrid fire control at EAFR, and successful targeting and fuzing of TP and TP-S rounds – <u>Accomplished!!</u>



Phase 3: Conduct integration and testing of the XM307 25mm and XM312 .50 cal ACSW with a stabilized RWS system on a moving Stryker vehicle at Redstone Arsenal 11 May Demonstration!





# Protector RWS Block 2 / XM307 ACSW Increased Lethality for Stryker



- RWS Block 2 provides the latest capability for the Stryker to engage targets with operational weapons
- XM307 provides low weight, low recoil, and increased lethality
- Combined, the RWS Block 2 and XM307 will provide the Stryker vehicles with:
  - Fire on the move
  - 25mm HEAB rounds
  - 25mm AP rounds
  - Dismount capability
  - Converts to .50cal XM312







## **Summary**





- XM307 provides low weight, low recoil, and increased lethality
  - 25mm HEAB
  - 25mm AP ammunition
- XM307 ROV, as funded by the FCS Program, shares a common operating group with the XM307 ACSW, but does not support dismounted operations
- The XM307 ACSW supports integration on a vehicle as well as dismounted operations
  - Demonstrated at RTTC 11May06
- When combined with the RWS Block 2, the XM307 ACSW will provide the Stryker vehicles with <u>INCREASED LETHALITY</u>



# Common Remotely Operated Weapon Station (CROWS) Description



- Provide Soldiers With Capability To Acquire And Engage Targets At Maximum Effective Range While Protected By Vehicle Armor
- Supported Weapons
  - MK19 GMG, Cal .50 M2 MG, M249 SAW, M240B MG
  - Growth To M230 & XM307
  - Weapons Can Be Quickly Interchanged By Soldier
- Sensor Suite Supports Day/Night Engagements
- Can Zoom Optics On Target Independent Of Gun Super Elevation
- Two-axis Stabilized Mount, Laser Rangefinder & Fire Control Software Support On-the-move Target Acquisition & First Burst Target Engagements







# **M101 CROWS Operations**







# **M101 CROWS Ongoing Applications**







# CROWS-Lightning Description



- Lightweight Application For Various Wheeled & Tracked Vehicles (From Hmmwvs & Heavy Trucks To Armored Personnel Carriers)
  - 200 Lbs Above Roof Including Weapon & Ammo (200 Rds)
- Moves Unprotected Gunners Into Vehicle Interiors
- Day/Night Capability To Identify & Defeat Targets Out To Max Effective Range Of Weapons While On-the-move
- M240 Or M249 Machine Guns W/Growth To Advanced Crew Served Weapon (XM307)







- Powered By Current Vehicle Capability
- 2-Axis Stabilization
- Traverse: 360° Continuous
- Range Of Elevation: -15° To +45°
   (Objective: -20° To +60°)
- Slew Rate: >30°/sec
- Safety Features:
  - Programmable Stops In Traverse
  - Manual/Emergency Back-up Operation Of Weapons Through Top Hatch



## SASS



To Acquire, Qualify & Field a

## **Commercial & NDI**

Semi-Automatic 7.62 x 51mm

Caliber Weapon System To Address

M24 Sniper Weapon System (SWS)

**Shortcomings** 



# XM110, 7.62mm Semi-Automatic Sniper System (SASS)



#### **Description:**

- Effective Against Personnel Targets And Light Materiel Targets
- Supplements Sniper's Role In Combat Operations
- Greater Firepower & Possible Standoff Ranges To Improve Sniper Survivability

#### Capabilities:

- Rapid Fire/Rapid Reload
- Suppressed Sniper Rifle
- Exceeds Rate Of Fire And Lethality Of M24 SWS
- Reduced Weight
- Primarily Anti-personnel Ranges > M24
- Enhanced Sniper Spotting Scope And Bipod

#### Status:

In Operational Testing





## XM110 Weapon Capabilities



#### The SASS Will Provide:

- Suppressed, Rapid Fire Lethality Against Personnel and Light Materiel Targets with High Capacity, Ammo Configurable, Quick Change Magazines and a Greater Shooter Focus
  - A "stay on the scope/stay on the gun" capability to rapidly engage multiple targets with multiple follow-on shots against moving/fleeting personnel and light skinned vehicles.
- Additional Responsiveness and Versatility That Supplements Sniper's Role To Support Combat Operations
- Easily Adaptable RSTA Systems For All-Weather, Day/Night Operation Based on METT-TC
- Enhanced Accessories For An Exponential Increase To Sniper Team Lethality, Survivability and Mission Flexibility



## XM110, SASS Specifications



- Ammunition: 7.62x51mm, M118 LR (anti-personnel) and M993 (armor piercing).
- Barrel Rifling and Twist: 20" barrel (not including flash suppressor), 1:11 right-hand twist, 5 grooves.
- Muzzle Velocity: 2,571 fps (784 mps) M118LR Ammunition / Barrel Length: 20" (508 mm).
- Max Effective Range: 1,000 meters (M118LR Vel: 1,099 fps @ 1km ).
- Overall Length: 40.5" with Collapsed Buttstock (1028 mm).
- Max Height w/20-Rd. Magazine and Day Optic: 10.25" (260 mm).
- Rifle Weights Unloaded: w/o sights/adapters/mounts: 10.81 lbs. (4.90 kg).
  - w/ Front & Rear Iron Sights, Bipod Adapter: 11.06 lbs. (5.01 kg).
  - w/ Iron Sights, Bipod Adapter, Leupold 3.5 x 10 SASS Scope: 12.82 lbs. (5.81 kg).
- M110 Complete: w/Leupold 3.5 x 10 SASS Scope, Bipod Adapter w/ LM Type S Bipod: 13.7 lbs. (6.21 kg).
- Sound Suppressor Weight: 1.96 lbs. (.89 kg.). Weapon Length with Sound Suppressor: 46.5" (1,181 mm).
- Unloaded 20-Round Magazine: 0.46 lbs. (.21 kg).
- Magazine w/20-Rounds of M118 LR: 1.62 lbs. (.73 kg).
- Bipod LM Type S Weight: 0.87 lbs. (.39 kg).
- Bipod Adapter Weight: 0.12 lbs. (.05 kg).
- Leupold 3.5x10x40mm w/ Illuminated TMR(0.5 MOA Elevation & Windage Adjustments)
   and 30mm SASS Mount: 1.76 lbs. (.79 kg.). w/M2 type (double revolution) Ballistic Cam

Fully Loaded 15.3 lbs

40.5"

46.5"





## **Weapon System Components**





- 7.62mm SR-M110 Match Rifle
- 20-Round Magazine (4 each)
- 10-Round Magazine (4 each)
- 600 Meter Backup Iron Sight
- Harris Bipod LM-S
- Bipod Rail Adapter
- Leupold 3.5-10x Scope with TMR® Reticle

- Padded Scope & Crown Cover
- Zippered Scope Soft Case
- Scope Caps
- One-Piece Long Range Scope Mount
- Tan Leather Competition Sling Assy.
- Military Sling Swivels installed on sling.
- SASS 7.62mm Sound Suppressor

- Magazine Pouches
- System Transport & Storage Case
- Weapon & Optic Cleaning Kits
- Weapon Deployment Kit
- Dewey Special 35.5" Coated Rod
- Bore Rod Guide for Dewey Rod
- DMR Flex Rod Kit

# TEAM

# XM151 Enhanced Spotting Scope & Tripod



- Associated Support Item Of Equipment (ASIOE) To SASS
- Addresses Shortcomings of M144 Scope for the M24 SWS
- Makes RFI Item Army Standard & Supportable



#### XM107 Urgent Requirement Fieldings

FY02	150
FY03	258

#### Rapid Fielding Initiative Fieldings

FY03	24		
FY04	770		
FY05	519		
FY06	1029		
FY07	690		
FY08	105		
TOTAL	3545		
SASS AAO	4492		
Left To Buy	947		



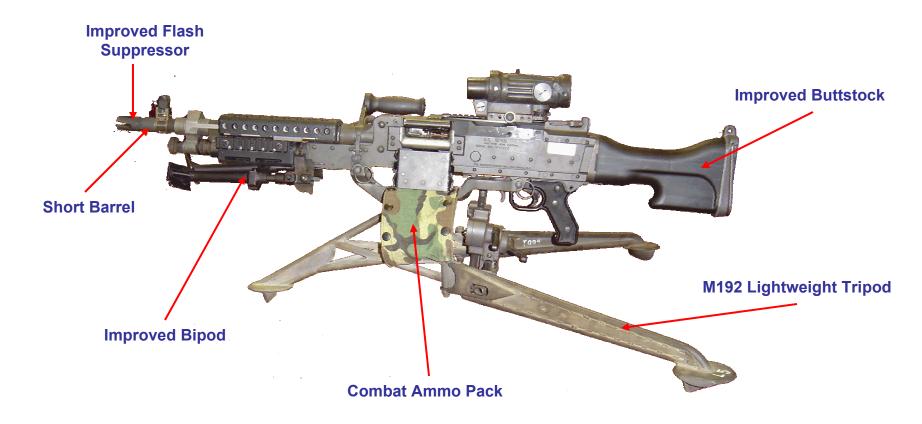






# M240B Medium Machinegun







# M240H, 7.62mm Machine Gun (Aviation Version)



#### **Description:**

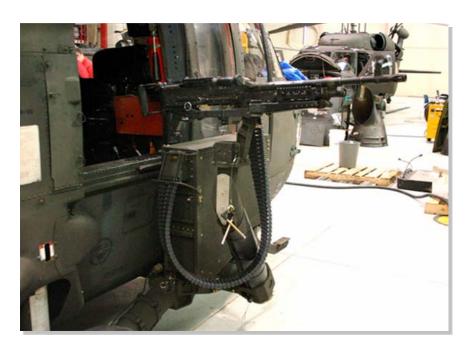
M240H 7.62mm Machine Gun Designed For UH-60 & CH-47

#### Capabilities:

- Demonstrate Reliability Equal To The M240B
- Deliver 2 Minutes Of Suppressive
   Fire And Be Removable/Employable
   In A Ground Role

#### Status:

Fielding Complete End Of FY07





# M240H, 7.62mm MG (Aviation Version)



#### Description:

 7.62mm Aviation Machine Gun which improves the Self Protection capabilities of the UH-60 and CH-47 Helicopters



- Demonstrate Reliability Equal To The M240B.
- Removable/Employable In A Ground Role

#### Pre-Planned Product Improvements (P3I):

- Hydraulic Buffer added to Spade Grip
- Lightweight Aluminum Ammo Can
- Lightweight Receiver

#### High Capacity Feed System:

 Provides two minutes of continuous suppressive fire (UH60 Flight tests May 06)







2,041 systems fielded to date, fielding complete end of FY07



# **Ground Firing**







# **Ramp Mount**







# **Ramp Gunner**







# GENERAL DYNAMICS Ordnance and Tactical Systems

# NDIA Small Caliber Presentation St. Marks Powder A General Dynamics Company May 16, 2006



# A Leading Supplier Of Propellants For Military Applications

• BALL POWDER® Propellant Loaded in over 95% of U.S. Military small arms ammunition





• Loaded Internationally in over a dozen countries for their Small Caliber Military Applications

• Ability to develop and deliver propellants specifically tailored to customer requirements.

# St. Marks Powder Research and Development

#### Resources

- ➤ Dedicated pilot plant
- ➤ Analytical and process Laboratories
- ➤ Ballistic test ranges
- ➤ Modeling and simulation capabilities



#### **Activities**

- ➤ Product and Process development and optimization
- > Technical services to customers
- >Support to operation: process, products and materials
- ➤ Contract R&D

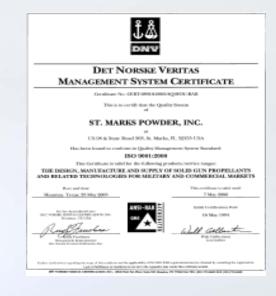
# The St. Marks Quality Program: Designed to Drive Continuous Improvement in Performance

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# Customer focused Team management approach Closed-loop design

## **Comprehensively integrated:**

- . Strategic planning
- Employee training and development
- . Product design and development
- . Supplier quality assurance
- . Production
- . Testing
- . Customer service
- . Performance review/improvement



ISO 9001 certified since 1994.
ISO 14001 and OHSAS 18001
certified in 2004.

## Lead Free 5.56mm BALL POWDER® Propellant

# Green 5.56mm BALL POWDER® Propellant

Projectile 62.0 grain, 20" barrel

<u>Propellant</u>	5.56mm round	Velocity(ft/s)	Pressure(psi)
WC 844	Standard M855	3020	55,000
<b>SMP® 842</b>	Green 5.56mm	3020	54,200

- BALL POWDER® Propellant designed for lead-free projectiles and primers
- Propellant additives developed for barrel decoppering



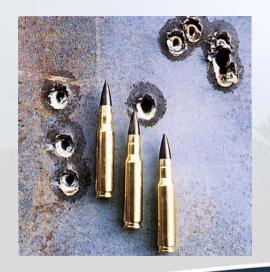
# 5.56mm M995(AP) BALL POWDER® Propellant

## 5.56mm Enhanced Performance

M995 projectile 52 grains: 20" barrel

Propellant Velocity(ft/s) Pressure(psi)

WCR 845® AP 3340 56,500



- High energy BALL POWDER® Propellant formulation designed for maximum performance
- Increased loading density of BALL POWDER®
   Propellant enhances ballistic performance

### 5.56mm Frangible BALL POWDER® Propellant

## 5.56mm Frangilbe

5.56mm Frangible projectile 55.0 gr, barrel 20"

**Propellant** 

Velocity(ft/s) Pressure(psi)

WC 747

3165

52,000

- BALL POWDER® Propellant designed for frangible projectile
- Propellant designed for proper 5.56mm gun functioning







# 5.56mm Flash Suppressed BALL POWDER® Propellant

• St. Marks Powder has developed propellant additives which reduce flash for 5.56mm ammunition



### 5.56mm Mk262 BALL POWDER® Propellant

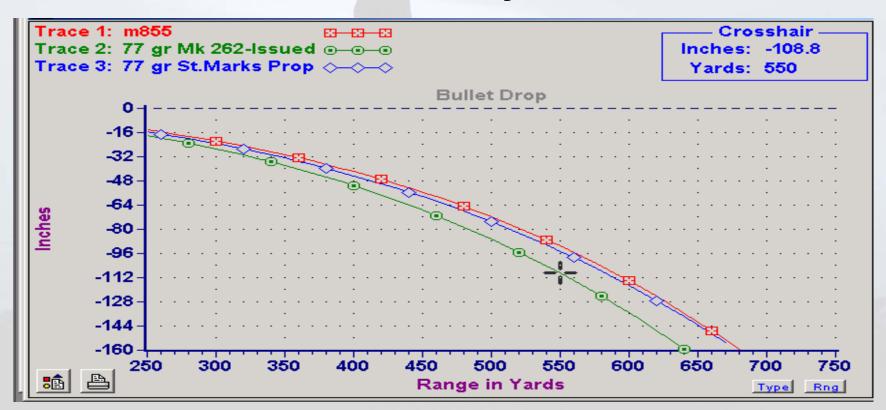
Enhanced Performance 5.56mm 77gr. projectile

	Muzzle	Mid Range	Max Range
1-1-1	Energy	Energy	Energy
M855	1256 ft-lbs	773 ft-lbs	347 ft-lbs
Current	1265 ft-lbs	738 ft-lbs	420 ft-lbs
Mk 262			
Mk262	1368 ft-lbs	805 ft-lbs	460 ft-lbs
Enhanced Performance	The second second		

• > 100ft/s increase in performance with BALL POWDER® Propellant

### 5.56mm Mk262 BALL POWDER® Propellant

• Same trajectory as standard M855 and higher lethality with BALL POWDER® Propellant



# Lightweight Small Arms Technologies (LSAT)











St. Marks Powder
A GENERAL DYNAMICS COMPANY

- St. Marks Powder is working with AAI team in the development of a propellant charge for the JSSAP Lightweight Small Arms Technologies (LSAT) Program
- The objective is to reduce the gun and ammo weight by 30-50%
- St. Marks Powder is applying BALL POWDER® Propellant technology for 5.56mm Case Telescoped round, 33% cartridge weight reduction and equal lethality







Standard 5.56mm M855

## 6.8mm SPC BALL POWDER® Propellant

## 6.8mm REM SPC vs. 5.56mm M855

5.56mm M855 projectile 62.0 gr, 6.8mm projectile 115 gr, barrel 16"

Propellant	Round	Velocity(ft/s)	K.E.(lbf-ft)	Pressure(psi)
WC 844	5.56mm M855	2900	1157	55,000
SMP® 745	6.8mm REM SPC	2500	1593	53,000

•6.8mm has ~40% more K.E. than the standard 5.56mm





# 7.62mm BALL POWDER® Propellant

### 7.62mm M80 Ball Enhanced Performance

projectile 147 gr, barrel 22"

<u>Propellant</u>	Velocity(ft/s)	K.E.(lbf-ft)	Pressure(psi)
WC 846	2735	2442	50,000
High Performance BALL POWDER® Propellan	>2860 t	2670	50,000
Ballistic Improvement	> +125		

• ~10% Increase in Kinetic Energy





# 7.62mm SRTA BALL POWDER® Propellant

• St. Marks Powder has developed BALL POWDER® Propellant for 7.62mm Short Range Training Ammunition (SRTA)

- BALL POWDER® Propellant designed to give desired ballistic while maintaining proper gun functioning
- St. Marks has developed propellant additives for decoppering and to improve barrel wear



# 7.62mm Flashed Suppressed BALL POWDER® Propellant

St. Marks Powder has developed propellant additives which reduce flash for 7.62mm ammunition

# 338 Lapua BALL POWDER® Propellant

### .338 Lapua Enhanced Perfomance

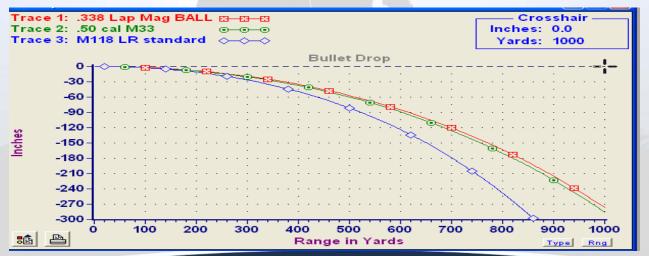
Projectile 250 grns., Propellant Charge 100 grns, 24" barrel

Propellant Velocity(ft/s) Pressure(psi)

OBP® 716 3,000 64,000

> 75 ft/s increase in velocity over factory rounds with BALL POWDER® Propellant

Enhanced 338 Lapua has similar trajectory as 50 cal M33





## 50 Cal M33 BALL POWDER® Propellant

### 0.50 BMG M33 Enhance Performance

0.50cal M33 projectile 650 gr, barrel 36"

<u>Propellant</u>	Velocity(ft/s)	K.E.(lbf-ft)	Pressure(psi)
WC 860	2910	12214	60,000
WC 869	>3110	13932	60,000

- > +200 ft/s increase in velocity with WC 869
- > 14% increase in Kinetic Energy with WC 869



# 45 ACP BALL POWDER® Propellant

M1911 45 ACP Ballistic Specifications

Velocity 855 +/- 5 ft/s, Pressure 16,500 CUP max. avg.

- St. Marks Powder has developed a BALL POWDER® Propellant which meets 45 ACP specifications
- 45 ACP BALL POWDER® Propellant is designed to be clean burning with reduced flash

# 45 ACP Flashed Suppressed BALL POWDER® Propellant

St. Marks Powder has developed propellant additives which reduce flash for 45 ACP ammunition

## 4.6 X 30mm PDW BALL POWDER® Propellant

### 4.6mm X 30 PDW BALL POWDER® Propellant

Projectile: 1.7 grams, propellant charge: 512 mg

<u>Propellant</u>	<u>Temp</u>	Velocity(m/s)	Velocity(ft/s)	Press(bar)	Press(psi)
<b>OBP® 390</b>	+21 C	688	2257	3,063	44,414
	-54 C	691	2267	3,107	45,052
	+52 C	669	2195	2,926	42,427

 OBP® 390 has enhanced performance over conventional propellants



### Conclusion

- St. Marks has fielded propellant technology to enhance performance and reduce muzzle flash for a variety of applications.
- St. Marks has a dedicated Research and Development group that is available to resolve technical issues.
  - Working on next generation of Small Arms Propellants for Increased Lethality, Improved Barrel Wear and Reduced Flash

# Ruptured Case in the M249 SAW

A Finite Element Analysis

# Who am I?

Clinton Fischer

Weapons Systems and Technology Weapons Technology Branch

RDECOM-ARDEC
Picatinny Arsenal, NJ 07806-5000

# Introduction

 Modeling and Simulation saves time and money

 Impractical to do real world tests on some failures

# What Happened



 Incidences of the M855 cartridge case rupturing during normal firing of the M249 Saw

 Cause was unable to be determined during live fire

# What Do We Need to Know

Do the tolerances of the cartridge case need to be more stringent?

If so, which tolerances are causing the problem; and how much do they need to changed?

# What Can Contribute

Separate Tolerances

Tolerance Stack-Up

Hardness Gradient

# Setup

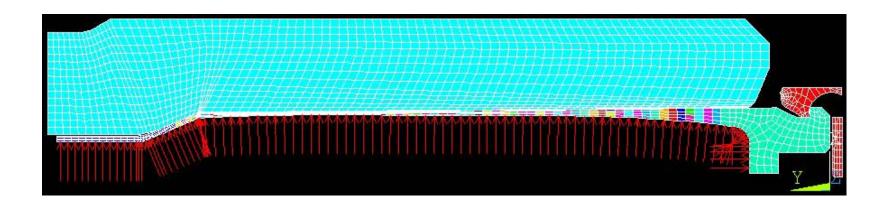
Geometry

Internal Pressure from Propellant

Extraction taken from T-D Curve

Materials – Brass Hardness Gradient

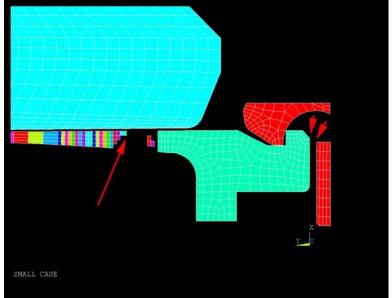
# Preliminary Modeling



- Axi-symmetric Model
- Several scenarios were considered

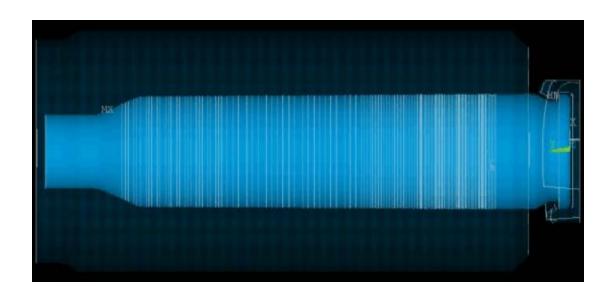
# **Observations**





- No rupture in nominal case
- Longitudinal stretching causes rupturing
- All hardness gradients ruptured at same location and time

# Secondary Results



- 3d Results corresponded to axi-symmetric models
- Brass material validated to 0.08% error

# Conclusions

- Space between the back of the case and the Bolt Face causes case rupturing
- Weapon head space is measured, case tolerance is limited to -0.006in
- Head space gauges measured in 0.002in increments

# What can be Learned

 Most cartridge cases are generally the same shape so will behave approximately the same way





# 5.56mm 30 Round Magazine Improvement Programs

#### Adam L. Foltz

Individual Weapons Branch
Small & Medium Cal. Weapons Systems Div.
US ARMY ARDEC
Bldg 65N
Picatinny Arsenal, NJ 07806
973-724-7096 – afoltz@pica.army.mil







# 5.56mm 30 Round Magazine Improvement Programs



### OBJECTIVE

- Enhance the performance, reliability, durability, and manufacturability of the current 5.56mm 30 round magazine
  - Short Term Solution
    - Improved follower and spring for current 30rd magazine
  - Long Term Solution
    - Redesigned composite magazine
  - Inspection Tool
    - Magazine feed lips inspection tool











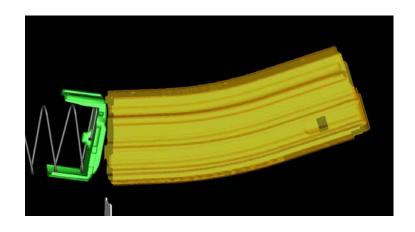






### Design Description

- Improved follower modified leg characteristics and improved interface with magazine housing profile to create a stabilized flow of follower/cartridges
- Improved Spring wider coil base creates uniform force distribution and prevents follower jamming
- Drop in replacement economical and logistically supportable













### Program Summary:

• Redesign 3Q04

Prototype Delivery
 1Q05

Prototype Evaluation 1Q05

Prototype Test2Q05

• Safety Release 2Q05

• User Evaluation 3Q05 (Ft. Benning)

• DCO 2-47 identified bad magazines from BRM training week

 Replaced springs/followers from bad magazines with improved springs/followers - No malfunctions

• Technical Test 1Q06 - 3Q06 (Aberdeen Proving Ground)

• Complete and Staff ECP 1Q07

Available in Supply
 3Q07



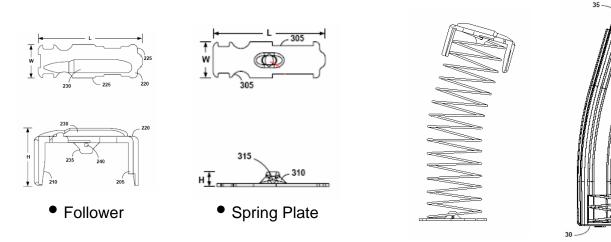






### Impact/Benefits

- Higher reliability and improved mean time between essential function failures, increased mission readiness
- Fewer demands for replacements
- Easier assembly/disassembly
- Estimated 5 year ROI 16.0, and 10 year ROI 32.2







Assembly





# **30 Round Composite Magazine**





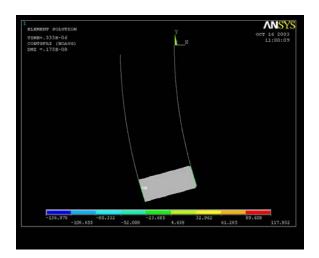


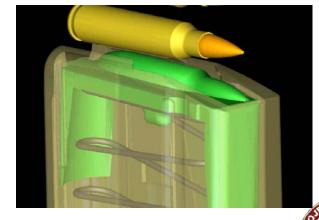
## **30 Round Composite Magazine**



### Design Description

- Redesigned magazine box profile, follower, spring, and implementation of a new housing material (Injection molded)
- Improved Profile continuous radius/smoother profile to create uniform flow path
- Improved Spring wider coil base creates uniform force distribution and prevents follower jamming









## **30 Round Composite Magazine**



### Program Summary:

Housing Profile Design
 4Q04

Material Evaluation
 4Q04 (150+ materials considered, 4 selected for evaluation)

Redesigned Follower/Spring
 1Q05

• 2<sup>nd</sup> Generation Prototype 2Q05

Material Evaluation
 2Q05 (Down select to 2 materials)

• Final Design Changes 3Q05 (Modified mold for material correction, Improved

bottom plate interface, Removed reflective finish)

• Prototype Test 4Q05 (Function Test, Drop Test)

Material 1 (Black)

Ambient: 8 drops – no failures (-50F): 8 drops – no failures

Material 2 (Transparent)

Ambient: 8 drops - no failures

(-50F): 8 drops – hairline crack on 6<sup>th</sup> drop, magazine fired, no stoppages

• Technical Test 1Q06 - 3Q06 (Aberdeen Proving Ground)

Available in Supply
 4Q07







#### **Composite Magazine**



#### Impact/Benefits

- Higher reliability, improved mean time between essential function failures, increased mission readiness
- Commercially available materials, eliminate need for coatings
- Manufacturability / Cost
- Easier assembly/disassembly method
- Improved interface with magazine well
- Transparent material will allow for round count identification



• Transparent (Smoke Tint)



• Black







#### **Composite Magazine**







• 1st Generation Composite Magazine

• Standard Aluminum Magazine





#### **30 Round Composite Magazine**



- Technical Test (APG)
  - •Tests to be Completed:
  - Initial Inspection
  - Reliability/Durability (M16/M4/M249)
  - High/Low Temperature
  - Salt/Fog
  - Rough Handling
  - Sand/Dust/Mud
  - Chemical Compatibility

- Immersion
- Ammunition Compatibility
- Accessory Compatibility
- 28 Day Storage
- Solar Radiation
- Temperature Shock
- Trans. Vibration









# Magazine Feed Lips Inspection Tool





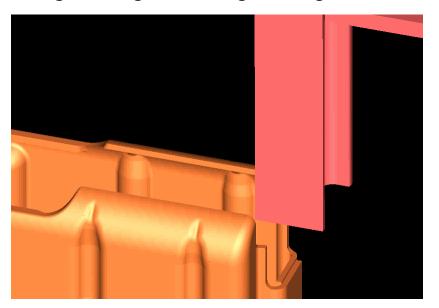


#### **Magazine Feed Lips Inspection Tool**



#### Design Description

- Designed to check Max/Min tolerance associated with 30 round magazine feed lips
- T-shaped GO/NO-GO tool
- Initiated by sliding tool against magazine groove contour







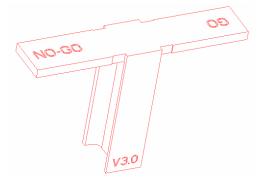


#### **Magazine Feed Lips Inspection Tool**



#### Impact/Benefits

- Currently no method to inspect feed lips other than visual
- Prevent use of malfunction prone magazines
- Increase reliability of associated weapon and soldier survivability
- Incorporate into existing annual gauging













### Project Manager Soldier Weapons Rapid Fielding Initiative (RFI) Update

Michael Friedman
Chief, Logistics and Integration Division

17 May 2006



#### Soldier Weapons RFI



- Bottom Line Up Front
- RFI has Made great progress in fielding
  - over 600,000 Soldiers Fielded
  - Is Sustainable path forward towardStandardization
  - Is Accountable

#### Project Manager Soldier Weapons RFI Items Fielded August 2002 - March 2006 over 600,000 Soldiers Fielded





Back-up Iron Sight
M68 CCO
Three-Point Sling
Weapon Light
TA31F 4X ACOG
M203 Day/Night Sight
Modular Weapon System Kit
M4 Forward Grip Bipod
M4 Improved Buttstock
M4/M16 Improved Cleaning Kit

M192/M122 Ground Mounts Improved Spotting Scope M24 Small Binoculars M145 Machineaun Optic

M249 Short Barrel
M249/M240B Spare Barrel Bag
M249 Collapsible Buttstock
M249 Ammo Soft Pack(100&200rd)
M240B Rails
M240B Combat Ammo Pack -



# PM Soldier Weapons RFI Coordination with Gaining Units



- Attend Coordination Meetings in Conjunction with PEO Operations Cell
- Identify unit needs ahead of time
  - Type unit(s): BCT or EAB?
  - MTOE and Modularity
  - Attain weapon density of unit
- Explain weapon accessory application to units
  - Gaining unit schedule for installation of weapon items to include location (either arms room or fielding site)
- Outline Training that will be provided
  - Obligation to gaining units to ensure training is provided on PMSW RFI equipment
  - If training is definitely not wanted, written request needed from Brigade Commander or higher



# Installation of Weapon Items



- TACOM Rock Island Total Package Fielding (TPF), on behalf of PMSW, installs the following:
  - Back Up Iron Sights on M4 Carbines and M16A4 Rifles
  - M249 Forward Rails
  - M240B Forward Rails
  - M249 Short Barrels and M249 Collapsible Buttstocks
  - M122A1 adapter kit (if needed)
  - M4 and/or M5 Adapter Rail Systems
  - M203 40mm Grenade Launcher MWS adapter kit
  - Gold extractor springs to the M4 carbine (not an RFI item, but springs are replaced for units in conjunction with RFI)
- Additionally, TPF trains unit armorers on the installation of above items



### **Training**



- PMSW provides Subject Matter Experts to instruct unit personnel through a "Train the Trainer" concept on the following equipment items:
  - M203 Day/Night Sight
  - M192 Lightweight Ground Mount (Tripod)
  - TA31F Advanced Combat Optical Gunsight (ACOG)
  - M68 Close Combat Optic
  - M145 Machine Gun Optic
  - Back Up Iron Sight (BUIS) used on M4/M16A4
- Training is conducted by PMSW core personnel or personnel from TACOM Rock Island New Equipment Training Branch



#### Sustainment Path Forward



- Strategy is to standardize all items for sustainment through the supply system
- 16 of 21 of items are standard
- 5 items in process of being standardized
- Interim sustainment through DLA prime vendor





# Effects of Small Caliber Munitions Through Intermediate Barriers

Mr. Chris Gandy ARDEC
Mr. Jeremy Lucid ARDEC
Mr. Shawn Spickert-Fulton ARDEC

May 17<sup>th</sup> 2006

# Believe nothing you hear, and only half of what you think you see.

- Rumors Suggest That Some 5.56mm Projectiles can not Penetrate Automobiles
- What are the Penetration Capabilities of 5.56 Ammo Against Intermediate Barriers?
- Can Fielded Munitions meet the Needs in Iraq & Afghanistan?

# Typical Intermediate Barriers

**Concrete Wall** 







This Vehicle ran a Checkpoint in Iraq. Could this have been Prevented?

# Phase I Scope

- Evaluate Terminal Effects of Select 5.56mm & 7.62mm Ammunition Through:
  - Automobile Windshields
  - Simulated Automobile Doors
- Collect Static & Dynamic Data
- Analyze Using EDR Methodology
  - Effective <u>D</u>amage <u>R</u>ating is a performance metric currently in development at Picatinny
- Short Study Rapid Results

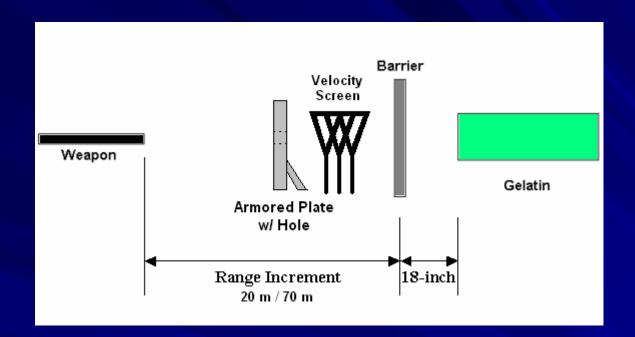
# Reality -> Model



Iraqi Checkpoint



Test Setup



# RANGE SETUP & TEST PARAMETERS

Ranges: 20m & 70m	M16	M4	M240		
	(5.56mm)	(5.56mm)	(7.62mm)		
M193 (5.56mm - 55grain)	Intermediate Barriers				
M855 (5.56mm - 62grain)	No Dowier (Deceline)				
MK262 (5.56mm - 77grain)	<ul><li>No Barrier (Baseline)</li><li>Windshields</li><li>Simulated Car Doors</li></ul>				
M80 (7.62mm - 147grain)					

# Windshield Test Setup

90° Windshield



45° Windshield



# Steel Plate Setup

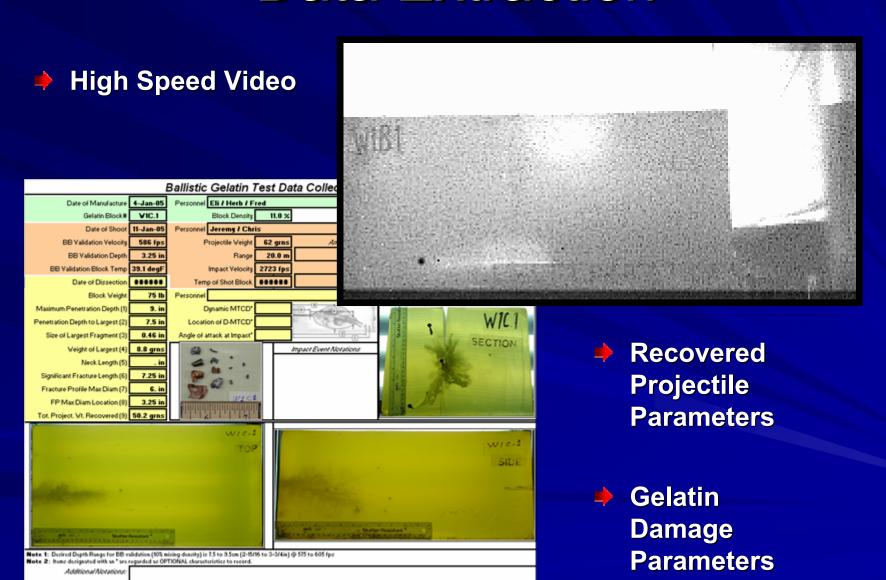
90° Steel Plates







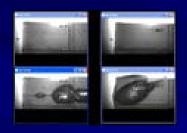
## **Data Extraction**

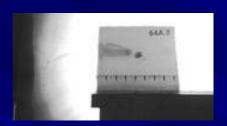


## Qualities & Considerations

(Big Picture)

#### **Shape and Type of Effect**





#### Mission(s)

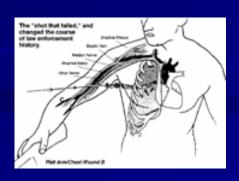
**Engagement Ranges** 

**Time to Acquire** 

Operational Environments

Number & Type

#### **Adequate Reach**



**Intermediate Barriers** 

**Body Armor** 

**Shot Lines** 

#### **Other Factors**

**Legal Restrictions** 

**Logistics** 

**Weapon Signature** 



**Consistency** 

## **Evaluating Results**

- Numerous metrics available
- Understand capabilities & limitations of each metric
- Remember large number of variables and scenarios encompassed
- Focus in on key performance characteristics and on thresholds of performance
- Understand the expected range of variation in "typical" use
- Assess general performance envelope

## Phase I Preliminary Conclusions

- All Shots Penetrated all Barriers
- Measurable Damage was Observed in Gelatin Simulant
- 7.62mm Produced more Damage Than 5.56mm
- Result Depends on Where Damage was Inflicted
- Results Entered into ARDEC Database Where Overall Performance Is Currently Being Gauged

# Phase II Methodology

Short Study – Rapid Results

If you can't Penetrate the Barrier then the Target can not be Reached

- Ammo Capability not Limitation
  - Can you Breach the Barrier?
  - How Often does this Occur?

# Phase II Scope

- Evaluate Terminal Effects of 1,600 Rounds of 5.56mm & 7.62mm Ammunition Through:
  - Automobile Windshields at Steeper Angles
  - Simulated Truck Doors w/ Increased Shell Thickness
  - Concrete Blocks
- Establish Quick Go/No Gages For Intermediate Barriers To Assist In Assessing The Threat

# Phase II Test Setup



#### Weapons:

- M4
- M16
- **M249**
- M24
- M240

#### Ranges:

- **75m**
- **200m**

# USAMU - Ft Benning

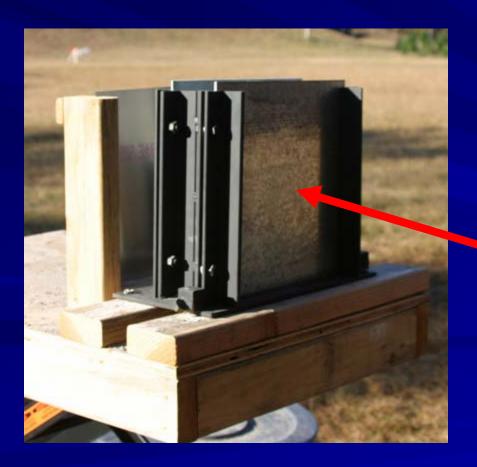
5.56mm Ammo	7.62mm Ammo
<b>→</b> M193	<b>→</b> M118LR
<b>♦</b> M855	<b>→</b> M80
MK262	
<b>♦</b> M995	

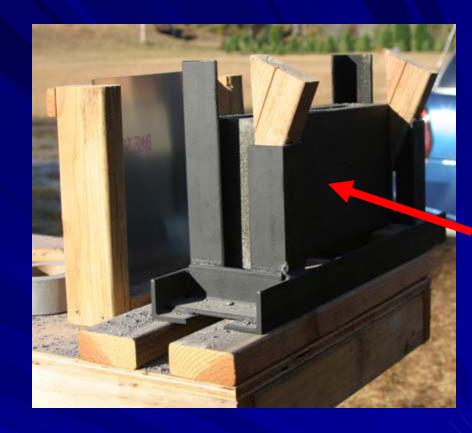


# Automobile Windshields

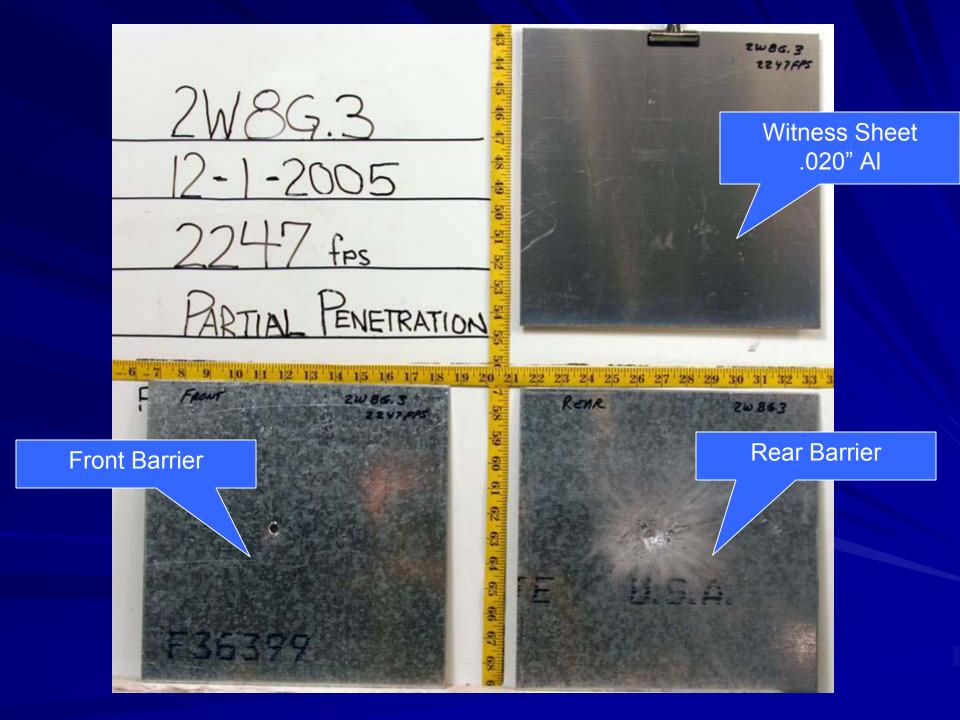


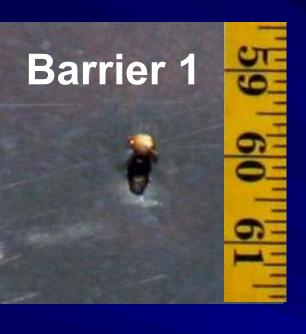
# Concrete -





**←** Steel





Partial Penetration



Witness
Plate 1



Full Penetration





# Preliminary Data - M16 (200m)

АММО	Windshield		Truck Door	Concrete
AIVIIVIO	Config 1	Config 2	Truck Door	Concrete
M855				
M995				
MK262				
M193				



No Penetration



**Full Penetration** 



**Partial Penetration** 

# Special Thanks

USAMU – Ft Benning

Without the help and cooperation of LTC Liwanag and the entire USAMU Team, this test would not be possible.

- Thank You

## Questions?

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# Navy Small Arms Program Status & Way Ahead JSSAP

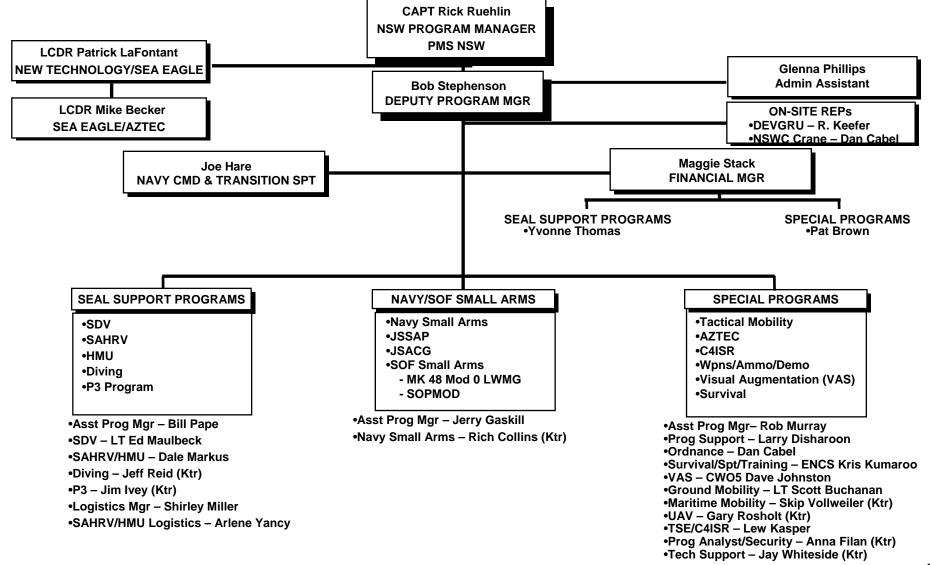
15 May 2006

Mr. Jerald Gaskill PEO-LMW/PMS-NSW APM Small Arms 202-781-0595



#### PMS NSW ORGANIZATION





# Small Arms Sustainment Way Ahead

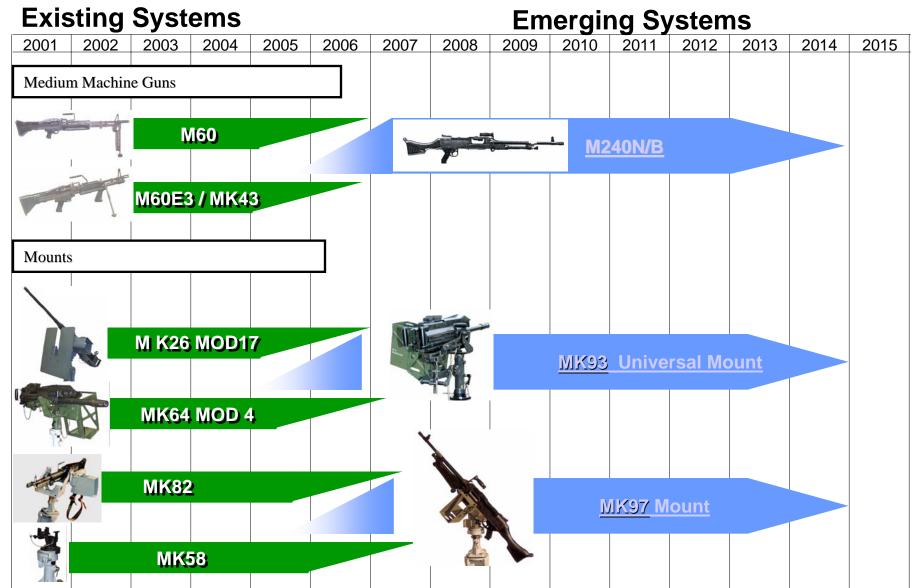
#### □ Actions being taken to reduce program costs

- Policy Changes: New way of doing business
  - No new unfunded allowances approved unless specifically directed by CNO N86.
  - Current approved but unfilled allowances will not be filled unless specifically approved by N86.
  - War reserve weapons will be used to satisfy Fleet requirements to the extent assets are available.
  - M60 machine guns repaired by retrieving parts (cannibalizing) from NRFI weapons already stock piled at NSWC Crane.
  - Funded allowance changes must be supported by CFFC and approved by N86.
- Lean Initiatives
  - End-to-End Value Stream Analysis
  - Rapid Improvement Events
    - .50 Caliber Overhaul
    - M-60 Machine Gun Repair
    - Weapons Material and Spare Parts
    - Weapons Maintenance, Test & Evaluation
    - Weapons Rework and P&P
    - Weapons Receiving and Shipping
    - On-going RIEs at Crane

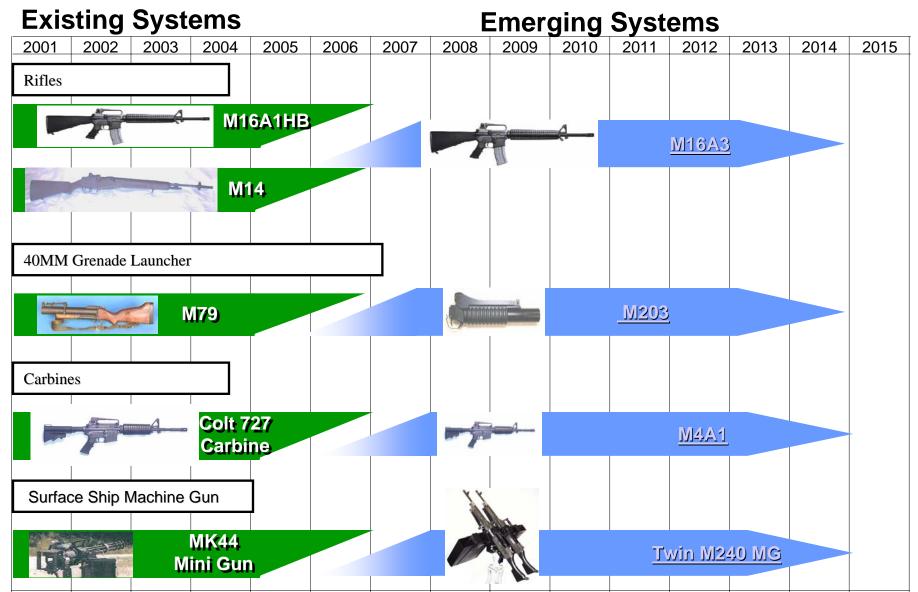
# Small Arms Sustainment Way Ahead (cont.)

- Repair vice refurbish small arms
  - Current cost saving measures:
    - Overhaul M-60 Machine Guns using cannibalized parts
    - Repair 12 GA Shotguns
    - Repair M16A3 Rifles
    - Repair Model 727 Carbines
    - Repair M11 9mm Pistols
    - Repair M9 9mm Pistols
    - Repair M203 40mm Grenade Launchers
  - Metrics developed during repair of sample weapons
    - Repair labor on each gun broken down by activity
    - Repair parts on each gun
    - Test Results on each gun
    - Other charges on each gun (P&P, ammunition support, etc.)

# **Small Arms Modernization Way Ahead**



### Small Arms Modernization Way Ahead (cont.)



### Small Arms Way Ahead Summary

- Executing new Business Model for Sustainment Way Ahead
- Roadmap Established for Modernization Way Ahead

#### **BACKUP**

# Small Arms 7.62mm Machine Gun Modernization

- Replace the obsolete M60 7.62mm Machine Gun (MG)
  - FY05 supplemental funds provided to procure the more robust M240 MG as replacement for the M60 MG
  - Funds used to procure:

•	1,925 each	M240B MG
•	1,925 each	Initial issue kits
•	1,250 each	MK97 mounts for the M240B
•	500 each	M125 ground tripod
•	500 each	Traverse & elevation mechanisms for the M125
•	218 each	M105 adaptors for M240B

Initial spares for the M240B

- Replacement of M60s with M240B will be on a priority basis
  - Training Commands
  - Units in direct support of GWOT
  - Deploying Strike Groups
  - Shore stations
  - Remaining Fleet units



#### Small Arms Mount Modernization

- Replace the MK26 Mod 17 and the MK64 Mod 4 with the less expensive and more robust MK93 universal mount
  - Capable of mounting both the M2HB .50 cal and the MK19 40mm Grenade Machine Gun
  - With an adaptor, can also mount M240 7.62mm Medium Machine Gun (this option is too expensive under normal circumstance)
- Replace the MK58 and the MK82 M60 Machine Gun mounts with the MK97 M240 Machine Gun mounts
  - MK58 and MK82 specific to the M60 family of Machine Guns
  - MK97 is specifically designed to mount the M240 family of Machine Guns



#### Small Arms Rifle Modernization

- Replace the M14 7.62mm As the Fleet's Primary Rifle
  - USN is only user of the M14 rifle
  - Too heavy for use in VBSS and MIO operations
  - Too long for use in VBSS and MIO operations
  - Shore establishment and expeditionary units have migrated from M14
  - Fleet desires M16A3 as replacement for M14 rifle
    - Few M14s to be retained for use in line throwing/burial at sea
    - Currently 4,354 M14 rifles in use aboard Navy vessels



# Small Arms 40mm Grenade Launcher Modernization

- Replace the M79 40mm Grenade Launcher with the M203
  - M79 is obsolete
  - M203 is designed to fit onto the M16 family of weapons. Results in increased flexibility
  - Relatively few (<900) M79s remain in service. Too expensive to maintain



#### Small Arms 5.56mm Carbine Conversion

- Convert the Model 727 carbine to M4A1 configuration
  - USN is only user of the Model 727 carbine
  - Model 727 carbine is out of production
  - Model 727 carbine is not capable of mounting sighting devices
  - FY05 O&MN supplemental funding will be used to convert 4000 each Model 727 to the M4A1 configuration
  - Conversion will take place at a rate of approximately 1000 per year FY06-FY09. Will accelerate conversion if labor and parts availability allow
  - Model 727 will be completely replaced by the end of FY09
  - Replacement of 727s will be done on a priority basis
    - Training Commands
    - Units in direct support of GWOT
    - Deploying Battle Groups
    - Shore stations
    - Remaining Fleet units



# Small Arms Surface Ship Upgrade/MK44 Replacement

- Replace the MK44 mini-gun system with Twin M240 MG.
  - MK44 Mini Gun (Sufficient FY06 funding to procure 55 ship sets)
    - System provided as a rapid response measure after USS Cole incident
    - Fires 7.62mm at 3,000 rounds per minute
    - Electrically driven w/six barrels
    - 80 systems currently in use by Fleet
    - No spare parts support in place
    - Difficult and expensive to maintain aboard ship
    - Requires ship alt to become a permanent emplacement
  - Twin M240 MG (Sufficient FY06 funding to procure 160 ship sets)
    - Fires 7.62mm at 1500 to 1900 rounds per minute (combined)
    - Can continue to fire if one gun fails
    - Any of the ship's M240s can be used to replace failed gun
    - M240 will be fully supported with procurement of 1925 weapons as part of FY05 WPN supplemental



# Small Arms Program WAY AHEAD

- Eliminate Small Arms Shortfalls (cont.)
  - •Actions to eliminate the shortfall
    - FY06 and FY07-Procure, repair, cannibalize, or convert >33,000 weapons using parts and contract labor procured with supplemental funding. With exception of MK19 40mm MG, M203 grenade launcher and M224 60mm mortar, all active duty shortfalls will be eliminated.

• M2HB .50 cal MG	1,200
• M16A3 Rifle	10,000
• 12 GA Shotgun	3,000
<ul> <li>Model 727/M4 repair/conversion</li> </ul>	2,429
• M11 9mm Pistol	1,700
• M203 40mm launcher	900
<ul> <li>M9 9mm Pistol repair</li> </ul>	6,200
<ul> <li>MK43 7.62mm MG cannibalize</li> </ul>	300
<ul> <li>M60 7.62mm MG cannibalize</li> </ul>	300
• M240 7.62mm MG	2775

• FY08 and FY09-Procure, repair, cannibalize, or convert >26,000 weapons.

By the end of FY11 (BARRING NEW UNFUNDED REQUIREMENTS) the shortage of RFI small arms to meet active allowances will have been eliminated with the exception of the M224 60mm mortar.

## Small Arms Program NEW REQUIREMENTS??

- Provisional Detainee Battalion
- Riverine Command Partially Funded
  - N751 providing funding for one active duty squadron
  - Two reserve squadrons planned for FY07
- Expeditionary Combat Battalion No Funding Identified
  - Size and requirements are unknown at this point (N757 sponsor??)
- Maritime Civil Affairs Group Funding Identified in FY08
- Navy Expeditionary Training Team Funding Identified in FY08
- Expeditionary Security Force Funding Identified in FY08
- Expeditionary Combat Arms Center Funding Identified in FY08
- Special Clearance Team One No Funding Identified
  - EOD unit (Part of MARFPCOM sponsor N757)
  - 6 new 11 meter RIBs. Small arms requirements unknown at this time





# "Harnessing the Power of Technology for the Warfighter"





# SOPMOD System Integration

Unit Survey Program

Mike Iovino Eric Babcock

17 May 2006

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## **Overview Agenda**



- SOPMOD Tasking
- Survey Team
- Results



## **Units Visited**



- 2nd Batt./75th Ranger Regt.
- 1st Special Forces Group
- 23rd Special Tactics Squadron
- 22nd Special Tactics Squadron
- 1st Special Forces Group (Okinawa)
- NavSpecWarGru One
- NavSpecWarGru Two
- NSW DevGru
- SDVT-1 (Hawaii)
- USASOC ANCOC (4 courses)
- 3rd Batt./75th Ranger Regt.
- 3rd Special Forces Group
- 21st Special Tactics Squadron

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## **Units Surveyed**



1st Special Forces Group	SEAL Team 2	21st Special Tactics Squadron
3rd Special Forces Group	SEAL Team 3	22nd Special Tactics Squadron
5th Special Forces Group	SEAL Team 4	23rd Special Tactics Squadron
7th Special Forces Group	SEAL Team 5	720th Special Tactics Squadron
10th Special Forces Group	SEAL Team 7	
19th Special Forces Group	SEAL Team 10	1st Batt./75th Ranger Regt.
20th Special Forces Group	SDVT-1	2nd Batt./75th Ranger Regt.
USAJFKSWC	SDVT-2	3rd Batt./75th Ranger Regt.
USASOC	NavSpecWarGru II	

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## 347 Operators Surveyed



USASOC	WARCOM	AFSOC	Rangers
1st SFG	SEAL Team 2	21st STS	2 <sup>nd</sup> Batt / 75 <sup>th</sup>
3 <sup>rd</sup> SFG			
3 <sup>rd</sup> SFG	SEAL Team 4	22 <sup>nd</sup> STS	3 <sup>rd</sup> Batt / 75 <sup>th</sup>
5 <sup>th</sup> SFG	SEAL Team 10	23rd STS SEAL	
7 <sup>th</sup> SFG	NSWG-II TraDet	14%	
10 <sup>th</sup> SFG	SDV Team 1	ССТ	
19 <sup>th</sup> SFG		25%	SF
20 <sup>th</sup> SFG			52%

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Ranger



## Survey Examples



SOPMOD Reticle Survey  1.1 If there is one thing that should be improved, replaced, or removed, what is it?  1.2 Choose two areas that SOCOM should fecus on to better prepare you for combut. Circle TWO  Rifles  Machine Gurs  Machine Gurs  Magazines  Thermal Sights  Ammanition  Thermal Sights  Mounts  Training  Optical Scopes  Other  Why?   Continue amoves on back as needed  SOPMOD Reticle Survey  owing questionnaire as specifically as possible. The resul as SOPMOD is: Fleave continue assesses on back if this is MOSRate  MOSRate  MosRate  Trijicos Knob **  Excellent **  Sofficient Needs **  Needs **  Needs **  Deficient Improvement 'Avoid if the source of the continue assesses on back if the source on back if the source on back in the source of the continue assesses on back if the source on back in the source on back in the source on back in the source of the continue assesses on back in the source on back in the source of the continue assesses on back in the source on back in the source of the continue assesses on back in the source on back in the source of the continue assesses on back in the source on back in the source of the continue assesses on back in the source on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in the source of the continue assesses on back in th	— SOPMOD / SOF Weapon Stud  collect comments and first hand feedback on SOF weapon solves.	ne purpose of this survey is to collect cor ortfalls and needs.  MOS/Rate_ nit:
1.2 Choose two areas that SOCOM should focus on to better prepare you for combat.  Circle TWO  Rifles  Lasers  Machine Guns  Pistols (back-up weapons)  Ammunition  Thermal Sights  Magazines  Iron Sights  Batteries  Mounts  Training  Optical Scopes  Other  Why?  Continue movers onback in needed  Continue movers onback in needed  Continue movers onback in needed	nat's Not	ECTION 1: What's Hot & What's Not
Circle TWO Rifles Machine Guns Machine Guns Night Vision Sights Pistols (back-up weapons) Night Vision Goggles Ammunition Thermal Sights Magazines Iron Sights Batteries Mounts Optical Scopes Other  Why?  Continue answers on back as needed  Which general purpose reticle do you prefer? (Circle one Red on Part of Circle one Red one Red on Part of Circle one Red on Part of Circle one	ld be improved, replaced, or removed, what is it?	I If there is one thing that should be imp
Machine Guns Pistols (back-up weapons) Ammunition Magazines Iron Sights Mounts Optical Scopes  Why?  Trijicon Knob = Excellent "Good Enough" Improvement "Awful"  Knob  Trijicon Knob = Excellent "Good Enough" Improvement "Awful"  Knob  Continue answers on back as needed  Continue answers on back as needed		rele TWO
Pistols (back-up weapons) Ammunition Thermal Sights Magazines Iron Sights Mounts Optical Scopes  Other  Why?  Continue answers on back as needed  Trijicon Knob = Excellent Sufficient Needs Deficient ("Awful")  Knob  Trijicon Knob = Excellent Sufficient Needs Deficient ("Awful")  Knob  Cord Enough Improvement "Awful"  (2.)  (3.)		
Ammunition Thermal Sights Magazines Thermal Goggles Iron Sights Batteries Mounts Training Optical Scopes Other  Why?  Continue answers on back as needed  Trijlon Knob = Excellent "Good Enough" Improvement "Awful"  (2.)  Continue answers on back as needed		
Magazines Thermal Goggles Iron Sights Batteries Mounts Training Optical Scopes Other  Why?  Continue answers on back as needed		
Iron Sights Batteries  Mounts Training Optical Scopes Other  Why?  Continue answers on back as needed  Continue answers on back as needed		
Mounts Training Optical Scopes Other		
Optical Scopes Other Why?  Continue answers on back as needed		
Continue answers on back as needed  Continue answers on back as needed		
1.3 What is in short supply (HOT)? OR What is there too much of (NOT)? Hease specify which HOT or NOT		
	'.')? OR What is there too much of (NOT)? Please specify which	3 What is in short supply (HOT)? OR W
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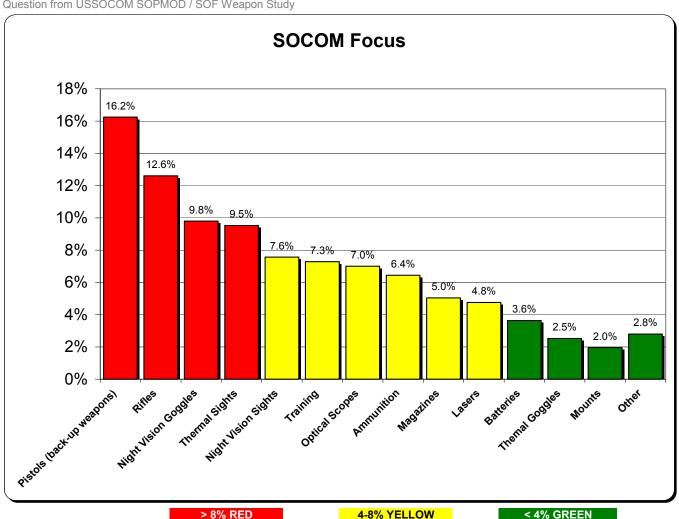


## Sample Results



1.2 Choose two areas that SOCOM should focus on to better prepare you for combat. (Circle TWO)

Question from USSOCOM SOPMOD / SOF Weapon Study



Note: Higher numbers indicate higher urgency, lower numbers indicate lower urgency.

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## Questions?

**UNCLASSIFIED** 



## Points of Contact



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## 5.56MM REDUCED RICOCHET LIMITED PENETRATION (RRLP), MK 255 Mod 0

May 16, 2006

Sung Y. Kim
Small Arms Ammunition Branch
Crane Division, Naval Surface Warfare Center
Crane, Indiana





- BACKGROUND/HISTORY
- CARTRIDGE DESCRIPTION
- CARTRIDGE SALIENT CHARACTERISTICS
- CURRENT STATUS





#### **BACKGROUND/HISTORY**

- SPECWARCOM Finalized Joint Operational Requirements Document (JORD) for Frangible Ammunition (April 98)
  - Based on existing frangible technology and operational requirements
- JORD was reviewed by other USSOCOM activities
- USSOCOM Approved JORD (Aug 98)





- One round, two missions
  - > Training
  - Operational
- Be used for
  - Close Quarter Battle (CQB)
  - ➤ Military operation in Urban Terrain (MOUT)
  - Visit Board Search and Seizure (VBSS)
  - > Counter-Narcotics (CN) Operation





- Initial Specification
  - > Minimal damage to training facility
  - Eliminate lead/toxic accumulation within the training facility
  - ➤ Eliminate lead/toxic emission from projectile and primer
  - Reduce ricochet hazard/No reverse splatter
  - Must be lethal
  - ➤ Be accurate (100Meters)
  - Must be waterproofed
  - Ballistic match to the M855





- NSWC, Crane evaluated production samples to determine if any commercially available cartridges could meet the JORD requirements
  - None of the cartridge types met all Operational Requirements
  - > Acceptable function and reliability
  - > Deficiencies:
    - Over penetration on hard target
    - Accuracy
    - Primer sensitivity
    - Waterproof
    - Lethality





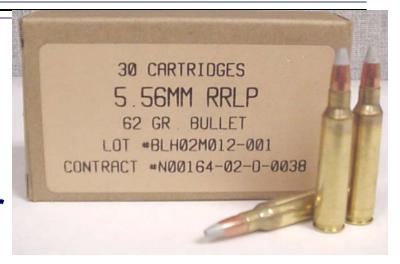
- SPECWARCOM funded Crane Navy to develop cartridge
  - ➤ Changed nomenclature from "frangible" to "Reduced Ricochet Limited Penetration"
  - ➤ Modified Initial Specification
    - Emphasized waterproof, accuracy, lethality and no backstop penetration (3/8" AR500 steel plate)
    - Included 10 inch barreled M4A1 carbine requirement
    - Dropped lead-free primer requirement
  - Awarded 5 Year IDIQ Contract to Black Hills Ammunition





## CARTRIDGE DESCRIPTION

- 62 grain jacketed frangible projectile – Copper/polymer composite core
- Winchester cartridge case that meets M855 specification
- Standard military No. 41 primer
- Western C1700 propellant

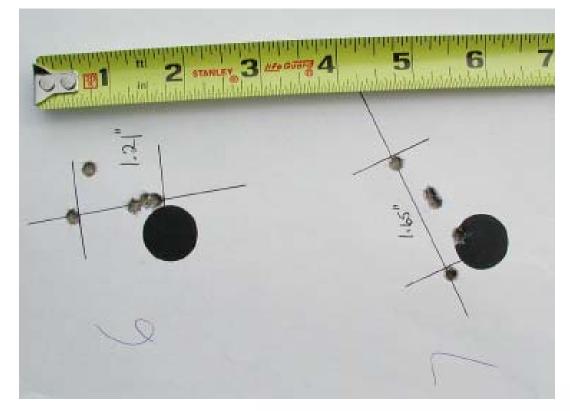






## **Cartridge Salient Characteristics**

- Chamber & Port pressures meet that of M855
- Accuracy less than 2 in. ES at 100 yards.







#### **Cartridge Salient Characteristics**

- Waterproof
  - ➤ No water intrusion after the cartridge was subjected to 28-31 psig water pressure for 115-125 minutes.
- Ricochet Fragments
  - ➤ No fragments penetrated deeper than 2.5" into 10% (by weight) Ballistic Gelatin after 45° impact on AR500 steel plate located 15 ft. from the muzzle
- Reverse Splatter
  - ➤ No reverse splatter toward the shooter position from AR500 steel plate 15 ft. away from the muzzle





#### Cartridge Salient Characteristics (cont)

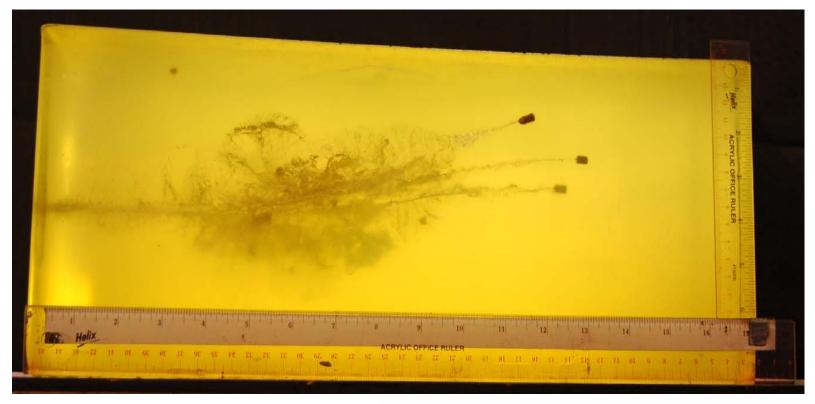
- Lethality @ 15 ft.
  - > 10% Ordnance Ballistic Gelatin
  - ➢ Initial yaw; 2 in. max.
  - > Temporary cavity length; 6 in. min.
  - > Temporary cavity diameter; 3 in. min.
  - > Temporary cavity diameter location; 3 to 6 in.
  - Number of fragments weighing 1 grain or more; 5 min.
  - > At least 50% of the fragments should be 7 in. or deeper
  - Maximum penetration depth should be 13 in. or deeper





## Cartridge Salient Characteristics (cont)

10% Ordnance Ballistic Gelatin Penetration

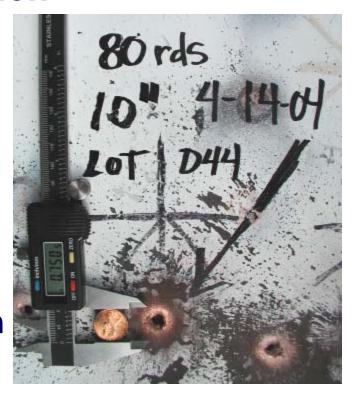






#### Cartridge Salient Characteristics (cont)

- AR500 Steel Plate Penetration
  - Muzzle to impact was maintained at 3 feet
  - Multiple shots within a 0.75 in. diameter area
  - No penetration occurred after 50 rounds using Mk
     18 Mod 0
  - Penetration occurred from 25 rounds to 50+ rounds using M4A1 Carbine







#### **CURRENT STATUS**

- JAG approved for training and operation, CONUS/OCONUS
- Completed WSESRB testing and requirement (2005)
- Received WSESRB IOC (Nov 2005)







## **ALGL Overview**

18 May 2006

# Dennis Lambrecht PM-ALGL

Distribution Statement A: Approved for public release; distribution unlimited

**UNCLASSIFIED** 





# Advanced Lightweight Grenade Launcher (MK47 Weapon System and Ammunition)







MK 285
Air Bursting



Standard HV 40MM

UNCLASSIFIED

Distribution Statement A: Approved for public release; distribution unlimited







## **ALGL** is a USSOCOM Acquisition Program.

Sponsor: USSOCOM PEO-SW



Fielded to: USASOC



Fielded to: NAVSPECWARCOM



Program Management & Life Cycle Sustainment: NSWC Crane Division



UNCLASSIFIED

Distribution Statement A: Approved for public release; distribution unlimited

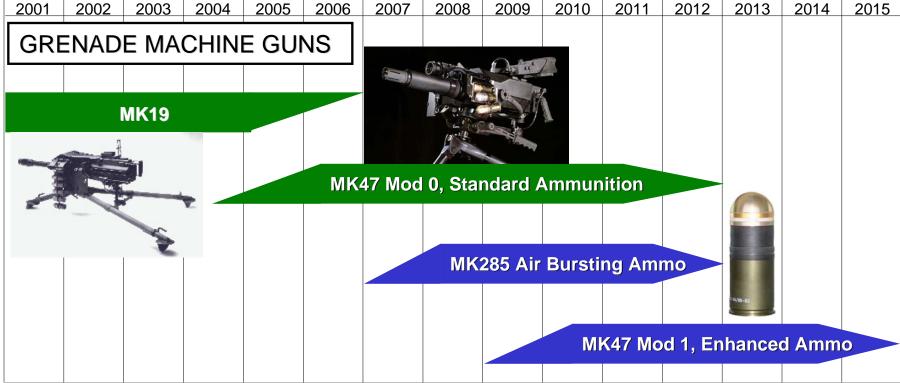






#### **ALGL TOPMAP**

#### **Existing Systems Emerging Systems Objective Systems**













**UNCLASSIFIED** 

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#### ALGL Overview

- MK47 Weapon System
  - NATO Nominated Weapon
  - Heavy Thermal Weapons Sight (HTWS) Capability
  - Improved Crew Served Weapons Mount (ICSWM) Foreign Comparative Test Project
- MK285 Air Bursting Ammunition







- ALGL Subprograms:
  - MK285 Air Bursting 40MM Ammunition
  - MK47 NATO Nominated Weapon Support
    - 3 MK47s to European Regional Test Center
    - 3 MK47s to North American Regional Test Center











#### MK47 with AN/PAS-13 HTWS



**UNCLASSIFIED** 

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- Foreign Comparative Test (FCT)
  - Improved Crew Served Weapons Mount (ICSWM) Project
    - FY06 new start
    - ICSWM "soft mount" for MK47 machine gun
    - Full and Open Competition
    - Source Selection process goal 4QFY06



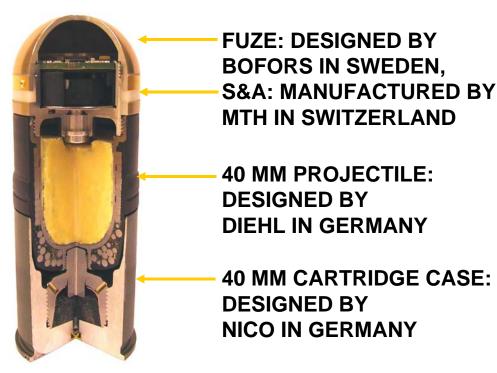






SIGHT: DESIGNED IN CANADA, IMPROVED AND MANUFACTURED BY RAYTHEON IN THE U.S.

MK47 WEAPON SYSTEM:
DESIGNED AND INTEGRATED BY
GENERAL DYNAMICS ARMAMENT
AND TECHNICAL PRODUCTS
(GDATP) IN THE U.S.



MK285 AMMUNITION: INTEGRATED BY NAMMO IN NORWAY



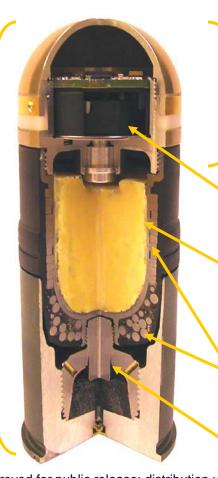




## Air-bursting ammunition for ALGL



MARK 285 MOD 0 CARTRIDGE



PROGRAMMABLE FUZE
MARK 438 MOD 0

SAFETY AND ARMING
DEVICE MARK 91 MOD 0

INSENSITIVE MUNITIONS EXPLOSIVE FILL

PRE-FORMED FRAGMENTS
INCREASE LETHALITY

LOW DISPERSION DESIGN

**UNCLASSIFIED** 

Distribution Statement A: Approved for public release; distribution unlimited







#### MK438 fuze

- Fuze set in chamber as hammer falls
- Mechanical Safe & Arming (S&A)
  - 2 independent safety locks, setback and spin
- MERCMECH improvements
  - Improved S&A support
  - Redundant circuitry
  - No on-board battery required







#### MK285 function modes:

- Point Detonating
  - function on impact, 18 40M S&A arming distance
- Airburst
  - Fire control sends power and time information
  - set range 100-1800 meters
  - Safe Separation Distance 58 meters
- Self Destruct
  - functions approximately 18 seconds after launch







INSENSITIVE MUNITIONS (IM) TEST RESULTS/ASSESSMENTS						
	FCO	sco	ВІ	FI	SD	SCJ
MK 285 Cartridge	Type IV Deflagration	Type IV Deflagration	Type VI No Reaction	Type VI No Reaction	Type III Pass	(Fail)

- Fast Cook Off (FCO)
- Slow Cook Off (SCO)
- Bullet Impact (BI)
- Fragment Impact (FI)
- Sympathetic Detonation (SD)
- Shaped Charge Jet (SCJ)







#### **IM TESTING**

- IM tests passed:
  - Bullet Impact (BI)
    - Type VI No Reaction = Pass
  - Fragment Impact (FI)
    - Type VI No Reaction = Pass
  - Sympathetic Detonation (SD)
    - Type III Reaction = Pass







## **IM TESTING (continued)**

- IM Tests; not passed, waiver required:
  - Fast Cook Off (FCO)
    - Type IV Deflagration reaction, fragments projected
    - Type V Burning reaction would pass
  - Slow Cook Off (SCO)
    - Type IV Deflagration reaction, fragments projected
    - Type V Burning reaction would pass







## **IM TESTING (continued)**

- IM Tests; failed, by analysis:
  - Shaped Charge Jet (SCJ)
    - (Fail) determined by analysis







#### **IM WAY AHEAD**

- IM Waiver & Strategic Plan
  - FY07 Strategic Plan
    - MK285 IM Waiver
    - MK285 on High Priority List
    - Funded Plan of Action & Milestones (POA&M) for IM Mitigation Effort







#### IM WAY AHEAD (continued)

- IM Mitigation Efforts:
  - MK285 POA&M, FY07-08
  - Test PA120 Container Modifications
    - Vent Overpressure
    - Reinforcement
  - Goal is Type V Burning Reaction for:
    - Fast Cook Off (FCO)
    - Slow Cook Off (SCO)







- MK285 Airburst Ammunition Testing
  - NAMMO Internal Qualification Tests
  - Contractor System Integration Testing
  - Government Qualification Test at NAMMO
  - Government Qualification Testing in US
- First Unit Equipped (FUE) plan 4QFY07







#### MK285 Ammunition



**UNCLASSIFIED** 

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#### MK285 Ammunition



**UNCLASSIFIED** 

Distribution Statement A: Approved for public release; distribution unlimited





#### MK285 Ammunition



**UNCLASSIFIED** 

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#### Objective 40mm Airburst Family:

- MK285 Airburst
  - Pre-fragmented Programmable High Explosive PPHE
- M430 HEDP PIP
  - ALGL Programmable High Explosive Dual Purpose
  - After-armor Incendiary Effect
- Programmable Training Round
  - Visible Airburst Signature







- MK47 Weapon System:
  - Ground or Vehicle Mounted



- Automatic 40mm Grenade Launcher
- Day/night Fire Control
- Uses Standard 40mm Ammunition
- Objective MK285 Airburst Ammunition
  - Effective Against Targets in Defilade



## **Advanced Lightweight Grenade Launcher**



**UNCLASSIFIED** 

Distribution Statement A: Approved for public release; distribution unlimited





#### Contact Information



#### Mr. Dennis Lambrecht **USSOCOM ALGL Program Manager NSWC Crane**

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Email: dennis.lambrecht@navy.mil



MAJ Eric Glenn **Systems Acquisition Manager - Weapons USSOCOM (PEO SOF Warrior)** Commercial: 813-828-9422

Email: glenne@socom.mil









## ANTI-MATERIEL SNIPER RIFLE CONGRESSIONAL PROGRAM



Mr. Neil E. Lee Senior Project Engineer AMSRD-AAR-AEW-M(D) Bldg. 65-N (973) 724-7970 neil.lee@us.army.mil

## ANTI-MATERIEL SNIPER RIFLE CONGRESSIONAL PROGRAM

- The objectives of this program were to develop technologies in the following areas:
  - Smaller/Lighter Individual and Crew Served Weapons
  - Innovative Breech Locking Designs
  - Innovative Weapon Mounts
  - Electrical Energy Generation and Storage
- Contractors
  - Barrett Firearms Manufacturing, Inc.
  - Cape AeroSpace
  - FN Herstal SA
  - Materials & Electrochemical Research (MER) Corporation

#### BARRETT FIREARMS MANUFACTURING, INC.

#### Lightweight M107 LRSR



#### **Specifications**

Caliber: .50 cal BMG

Weight: 23.7 lbs Length: 57 inches

Operation: Semi-Automatic, Gas

Material change provides 30% weight reduction of M107 LRSR.

#### BARRETT FIREARMS MANUFACTURING, INC.

#### XM500 Anti-Material Rifle



#### Specifications

Caliber: .50 cal BMG

Weight: 26 lbs

Length: 46 inches

Operation: Semi-Automatic, Gas

Increased mobility, lighter, shorter length than M107 LRSR.

### BARRETT FIREARMS MANUFACTURING, INC.

#### XM109 Anti-Materiel Payload Rifle





Caliber 25mm, Objective Individual Combat Weapon

**Operation** Semi-Automatic

**Barrel Length** 17.6 inches (44.70 cm)

Rifling Twist 1 in 22

**Rifle Weight** 35.12 pounds (15.93 kg)

Overall Length 46 inches (116.84 cm)

### CAPE AEROSPACE

 Cape AeroSpace demonstrated mechanical to electrical energy conversion using piezoelectric crystals in gas and recoil operated weapon systems





### FN HERSTAL, S. A.

- FN Herstal SA prototype High Velocity 40mm Grenade Launcher
- Provides man portable high velocity 40mm capability



#### **Specifications**

Weight 17 lbs (threshold)

Length 32 Inches

Height 9.25 Inches

Width 5.0 Inches

# MATERIALS & ELECTROCHEMICAL RESEARCH CORPORATION

- Lightweight composite .50 cal barrels
  - Thin Metal Liner, Tantalum-Tungsten
  - Ceramic Liner, Silicon Aluminum Oxynitrate





# ANTI-MATERIEL SNIPER RIFLE CONGRESSIONAL PROGRAM





### SUMMARY

- The objectives of this congressional program were met.
- The demonstrated technologies can be further developed to address Joint Service needs.



**Presented by:** 

Mr. Chuck Marsh

Sr. Mechanical Engineering Technician

Tel. (812)-854-4110 / DSN 482-XXXX

Email: charles.marsh@navy.mil





### BACKGROUND

- Current ammo test protocol only covers temperature range of -65°F to +165°F
  - M16 family of weapon systems can reach chamber temperatures of 400°F in extreme use.
- Effects on chamber pressure over +165°F were unknown.
- Rail Interface System (RIS) test at BlackWater in July 05 reported stuck cases and blown primers after 3-4 magazines fired (using MK 262 MOD 1).





## ·SCOPE

- -Record actual chamber temperature of M4A1 carbine during extreme use.
- -Transfer the M4A1 carbine chamber temperature results to a chamber pressure test barrel.
- -Record chamber pressure when cartridge is subjected to extreme chamber temperatures.





- M4A1 Chamber Temperature
  - Six (6) weapons fitted with thermo couplers. (Installed externally at shoulder of chamber).
    - 3 Wpns for M855, 3 for MK 262
  - Firing Sequence
    - One weapon fired in semi-auto, one double tap, and one 3-5 round bursts. Seven (7) magazine fired through each weapon.
    - The magazines were reloaded and the firing sequence repeated (420 rnds each weapon total).





- M4A1 Chamber Temperature (cont)
  - Data Recorded
    - Initial chamber temperature
    - Chamber temperature at the end of each magazine
    - Duration (time) required to fire each 30 round magazine

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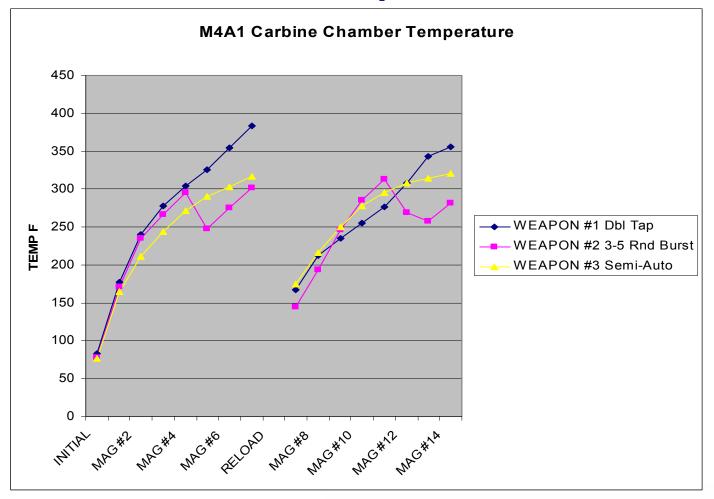
## M4A1 Chamber Temp Results-MK 262

	WEAPON #1 Dbl Tap		<b>WEAPON #2</b>	3-5 Rnd Burst	WEAPON #3 Semi-Auto	
	TEMP	DURATON	TEMP	DURATON	TEMP	DURATON
	(F)	(sec.)	(F)	(sec.)	(F)	(sec.)
INITIAL	83		78		77	
MAG #1	177		171		165	52
MAG #2	240	49	235	45	211	60
MAG #3	278	41	266	35	244	60
MAG #4	304	55	295		272	61
MAG #5	326	45	247		290	64
MAG #6	354	47	275	38	303	60
MAG #7	384	48	302	48	317	63
RELOAD						
INITIAL	167		144		175	
MAG #8	213		193	30	216	55
MAG #9	235	40	246	35	250	55
MAG #10	255	40	285	32	278	58
MAG #11	277	60	313	83	296	57
MAG #12	308	50	269	185	308	60
MAG #13	343	60	258	140	314	59
MAG #14	356	48	281	35	320	63





## M4A1 Chamber Temp Results-MK 262







### CHAMBER PRESSURE RESULTS

TEMP/TIME	BLH03M032-001		BLH04B038-001		LC-05G380-491		BLH05L096-001	
	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.	AVG.	MAX.
330F/15 sec	70,261	73,657	71,772	75,984	56,015	56,939	52,771	55,880
330F/30 sec	82,769	89,052	80,469	82,857	52,572	54,544	59,707	66,022
330F/60 sec	85,662	87,612					61,602	64,945
300F/15 sec	74,525	77,354	71,080	72,337	54,847	54,847	52,300	55,787
300F/30 sec	82,777	82,777					53,830	56,685
300F/60 sec							65,997	69,515
250F/15 sec	66,599	68,537	65,519	66,234				
250F/30 sec	74,523	77,134	70,855	73,954			53,510	59,482
250F/60 sec							63,511	65,420
200F/15 sec	65,172	67,502	63,813	65,267				
200F/30 sec	67,989	73,472	71,175	72,247				
200F/60 sec							57,313	59,920





## **CONTROLLER, HEATER & ADAPTER**







**5.56MM CHAMBER ADAPTER** 







### CONCLUSION

- Current small arms ammunition test standards do not address operational chamber temperatures recorded in the M4A1 carbine. (Impacts all M16 weapon systems family).
- AA53, MK 262 MOD 1 propellant was modified to increase high temperature stability.





## CONCLUSION (cont)

- AA53 specification was revised to include high temperature propellant stability test.
- All NSWC Crane non standard ammo projects designed for use in the M16 family of weapons will be subjected to the high temperature stability test.
- Impacts future NSWC Crane ammo items designed for use in a magazine fed, semi-auto weapon system.

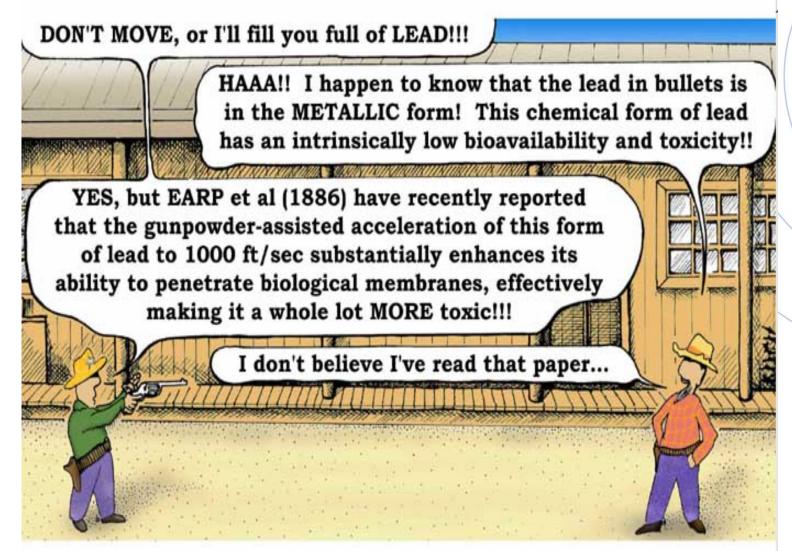


## PRECISION, PEOPLE AND TECHNOLOGY



May 15-18, 2006

## **Lead Ammo Toxicity Debate**



### **Green Program**

## **General Objectives**





- "Green" ammunition
- Environmental friendly
  - Groundwater
- Safe working environment
  - > Non Toxic Primer
  - ➤ Non Toxic Projectile

- Transparent to users
  - Combat/Training ammo
  - > Full military performance
- Same costs as lead core ammo
  - High-rate Production

3



## TIMELINE Nammo Non Toxic Ammo Program

stablishe	Requirement Esta	Swedish	1995
stablishe	Requirement Esta	Swedish	1995

Swedish Specification Established 1996

1995-1999 Design Trade Studies

**Production Studies** 1997-1999

> Initial Production to Sweden 1999

**Production Improvements** 1999-2002

> 2001 Norway Adopts Nammo NT

> 2004 Finland Adopts Nammo NT

2004 NATO Qualification Approval

## Specific "Green" Objectives

- > External environment Groundwater
  - > No lead or heavy metals in the projectile
  - ➤ Outdoor range issue
- Safe working environment
  - Non toxic primer (no toxic gas/particle emissions)
  - Non toxic projectile (no toxic base oxidation emissions)
  - > Indoor range issue

## General Design Objectives

- > Full Military (NATO) Performance:
  - > Accuracy
  - > Terminal Ballistics
    - > Penetration
    - ➤ Wound Ballistics
  - Storage and Use Environments
    - > -65°F to +125°F (-54°C to +52°C)
  - > Function in all NATO weapons
  - > Barrel erosion
  - > Smoke, flash and fouling
  - > Full training and combat interchangeability
- > Cost Delta < 15% more than lead ammunition

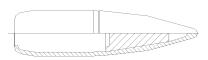
## **Evaluated Projectile Materials & Designs**

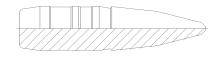
Metal-**Polymer** Composite Core & Steel Tip **Gilding Metal Jacket** 

Solid Steel and **Solid Brass** 

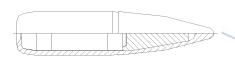
Monolith **Steel Core** Gilding Metal **Jacket** 

**Copper Core** & Steel Tip or Steel Core & Steel Tip **Gilding Metal** Jacket









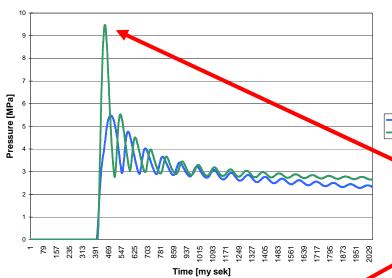
**≻High Cost** 

**≻**Penetration >Barrel Erosion **≻**Copper Fouling

> Penetration **▶**Barrel Erosion

>Steel Core & Steel Tip selected >Lower cost >Minimal Copper exposure

## Primer - Powder Optimization





# Optimization of primer – powder system critical

Green Primer design considerations;

- High peak pressure
- More hot gases than hot particles

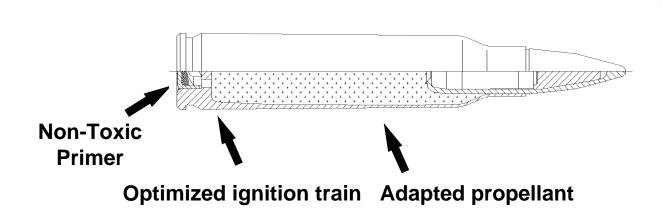


## Nammo Green Ammunition Concept

5.56 mm & 7.62 mm NATO

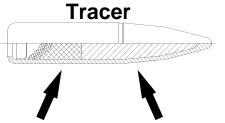
**Optimized** Soft-steel core

Hardened steel penetrator



**Optimized** gilding metal jacket

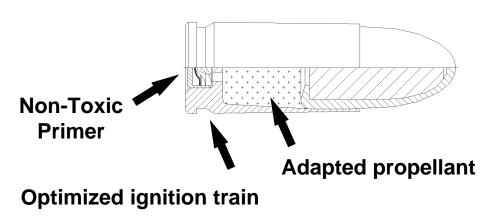
**Ball HP** 

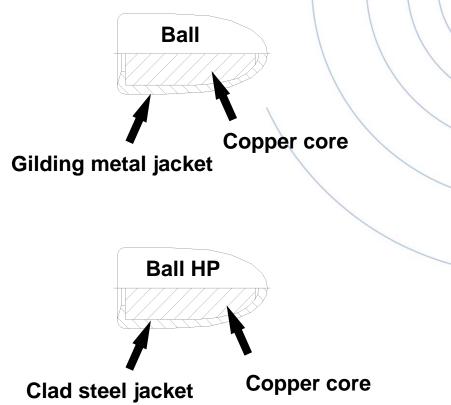


Clad steel jacket Copper core

## Nammo Green Ammunition Concept

#### 9 mm NATO





## Norwegian Groundwater Study

Laboratory Study: Relative change (%) in soaking of dissolved heavy metals when firing Nammo Green ammunition at Norwegian firing ranges in service

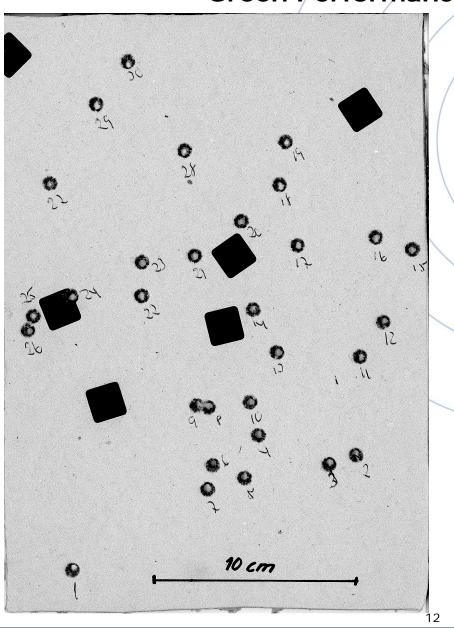
	Lead	Copper	Antimony	Zinc	Iron
Range A	-35%	5%	-37%	-24%	2800%
Range B (wetland)	-86%	17%	-93%	-75%	2100%
Range C	-17%	-31%	-75%	-13%	21%
Average	-46%	-3%	-68%	-37%	1636%

## **Green Accuracy**

#### 7.62 mm BNT 9 HP

Lot 01-CG-05 (5/12/05) 30 rounds @ 550 m

- > Std. Dev. Hor. 5.5 cm
- > Std. Dev. Vert. 6.2 cm
- ➤ NATO Req. Std Dev < 20 cm
- ➤ Mean Radius 7.6 cm
- ➤ US Req. MR < 6 " (15.2 cm)

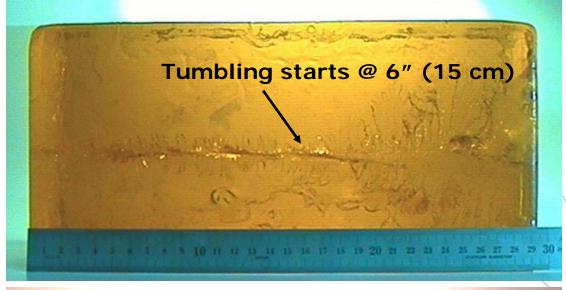


## **NATO Test Target - Penetration**

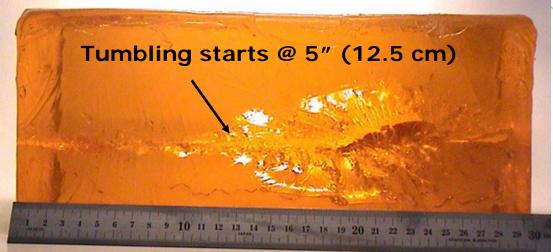
Nammo Cartridge	Nammo BNT-HP Penetration	Standard Ball Penetration
5.56 mm BNT 4 High Performance	3.5 mm NATO plate @ 620 m @ 0° obliquity	3.5 mm NATO plate @ 550-600 m @ 0° obliquity
7.62 mm BNT 9 High Performance	3.5 mm NATO plate @ 950 m @ 0° obliquity	3.5 mm NATO plate @ 550-600 m @ 0° obliquity
9 mm BNT 7 High Performance	3 mm mild steel @ 70 m @ 0° obliquity	3 mm mild steel @ 5-10 m @ 0° obliquity

## Test Target – 10 % Gelatin

7.62 mm Ball M80



7.62 mm BNT 9 HP



## Real Target - Building



## **Test Target - Concrete**

125 mm (5") 1999 Vintage **Concrete Block**  7.62 mm Ball M80 23 rounds Two bursts

7.62 mm BNT 9 HP 10 rounds One bursts







## **Real Targets - Trucks**

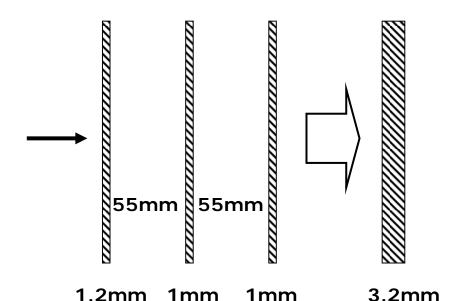




Namme

## Test Target – Medium Truck

#### **NATO Medium Truck STANAG 4498**

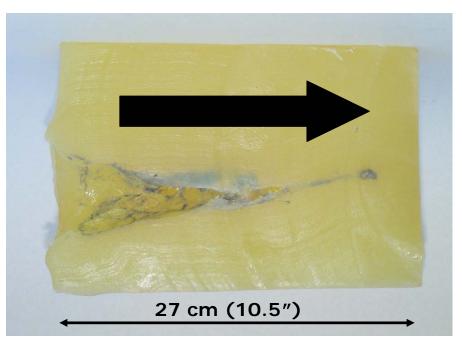


Material: Mild steel

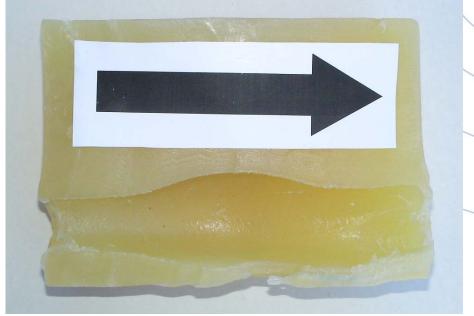


## Target Effect – Medium Truck

7.62 mm Ball M80



7.62 mm BNT 9 HP



# Nammo Green Ammunition NATO Qualification Status

Nammo Cartridge	Specification	NATO QA Status
5.56 mm BNT 4 High Performance	STANAG 4172	AC/225-128A (2004)
5.56 mm TNT 4	STANAG 4172	In progress
7.62 mm BNT 9 High Performance	STANAG 2310	AC/116-32A (2004)
7.62 mm Tracer Non Toxic 9	STANAG 2310	AC/116-37A (2005)
9 mm BNT 7 High Performance	STANAG 4090	In progress

## Nammo Green Ammunition Family

#### In Production:

- > 5.56 mm Ball Non Toxic 4 High Performance
- 5.56 mm Tracer Non Toxic 4
- > 5.56 mm Ball Non Toxic 3 Short Range
- > 7.62 mm Ball Non Toxic 9 High Performance
- > 7.62 mm Tracer Non Toxic 9
- > 7.62 mm Ball Non Toxic 6 Short Range
- > 9 mm Ball Non Toxic 7 High Performance
- > 9 mm Ball Non Toxic 7

#### **Under development:**

- > 5.56 mm Dim Tracer Non Toxic 4
- > 7.62 mm Dim Tracer Non Toxic 9

## ... and Finally



22

## ... and Finally

..so far 300 tons less lead polluting the environment and creating health hazards

Thank you for your attention!
Any questions?

#### **Session I - Ammunition**

Session Chair - Mr. Ralph Mazeski, US Army ARDEC, Picatinny Arsenal, NJ

- 1:30 PM 5.56mm Reduced Ricochet Limited Penetration (RRLP) Cartridge
  - Mr. Sung Y. Kim, NSWC Crane, IN
- 1:50 PM Small Arms Ammunition Operational Temperature Stability Test and Evaluation
  - Mr. Charles T. Marsh, NSWC Crane, IN
- 2:10 PM Development of Non-Toxic Ammunition in Scandinavia
  - Mr. Thomas Mauritzson, NAMMO
- 2:30 PM Advanced BALL POWDER® Propellant Technology for Enhanced Lethality and Green Ammunition
  - Mr. Steve Faintich, St. Marks Powder







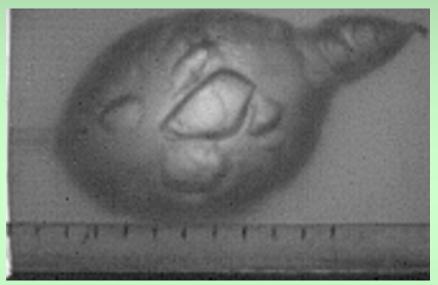






### Gelatin Impact Modeling

In support of PM-MAS ES-1A-9000





#### Mark D. Minisi, MSME

US Army TACOM ARDEC, Infantry Weapon Systems; Small and Medium Caliber Technical Modeling & Simulation Team Leader AMSRD-AAR-AEW-M (D), Bld65

Picatinny Arsenal, NJ 07806-5000

PH: 973-724-4326, DSN 880-4326







#### **Project Goals**

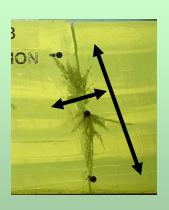






- Create a numerical model capable of predicting the effects on the projectile and the gelatin when struck by M855 ball ammunition at impact velocities applicable to the military
  - Effects on projectile in gelatin
    - Effects of Striking yaw at impact
    - Resulting yaw history in gelatin
      - Velocity decay
      - Final penetration depth
    - Deformation and fragmentation\* of projectile
  - Damage to gelatin
    - "Dynamic" cavitations
    - "Static" fractures\*; size and location





<sup>\*</sup> Secondary goals with higher risk than the primary



#### **Project Path**







- 1. Code identification
- 2. Material Model identification
- 3. Material Property Acquisition
- 4. Incremental Gelatin Impact Simulation Development
  - Rigid Projectile, Low Velocity
  - Rigid Projectile, High Velocity, with Yaw
  - Deformable Projectile, Low Velocity
  - Deformable Projectile, High Velocity
- Hard Targets
  - Steel
  - Bone
  - Glass
  - Wood

<sup>\*</sup> Secondary goals with higher risk than the primary

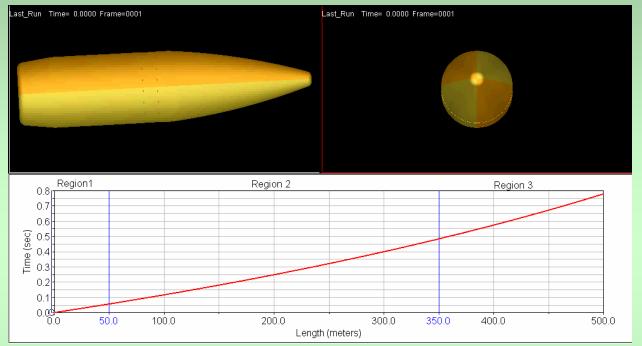






#### Why FEA?

#### Complex Projectile yaw motion; Precession / Nutation



#### Projectile Deformation and Failure

•Presented Area's contribution to drag, velocity decay,

and ultimately damage

•Increased *Physical Understanding* of impact events inherent with model development

Applying the proper Material models







M855's taken from 10% gelatin after 5m impacts



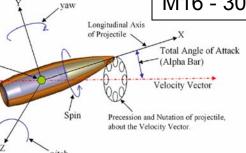
MK18 - 2528 fps



M4 - 2850 fps



M16 - 3052 fps







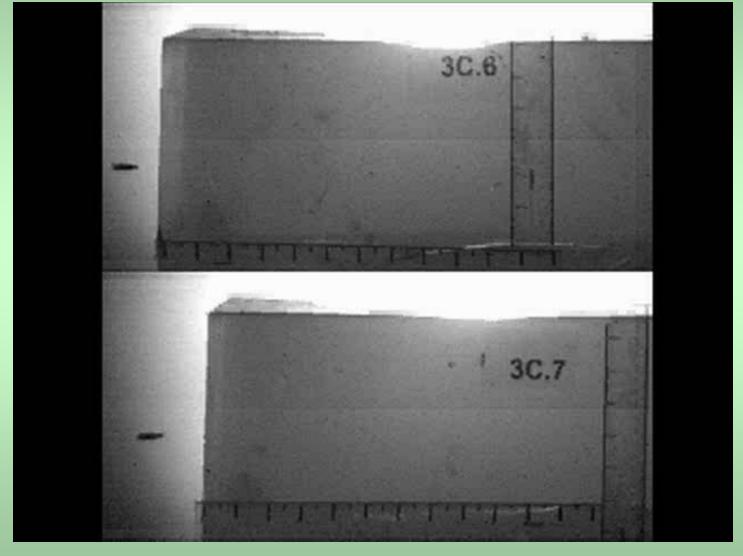


#### Angle of Attack at Impact:





#### Projectile Loading and Fragmentation







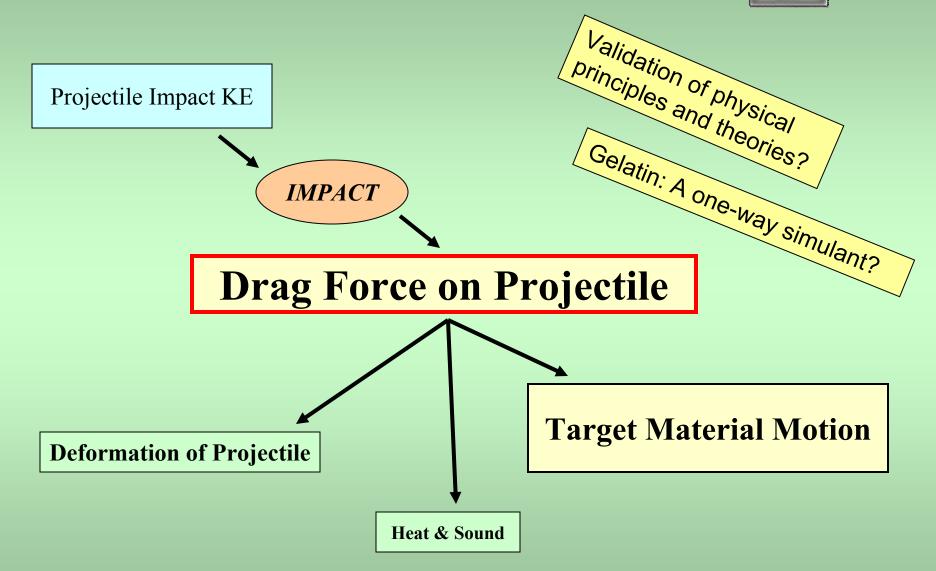


## The Physics; Impact Basics















#### Material Models; *Metals*





Johnson Cook

Strength Model

$$\sigma = [A + B\varepsilon^{n}] [1 + C \ln \dot{\varepsilon}^{*}] [1 - T^{*m}]$$
Yield & Strain Rate Thermal
Strain Hardening Effects Effect

Johnson Cook Failure Model 
$$\varepsilon_{f} = \begin{bmatrix} D_{1} + D_{2}^{D_{3}\sigma^{*}} \end{bmatrix} \begin{bmatrix} 1 + D_{4} \ell n \varepsilon^{*} \end{bmatrix} \begin{bmatrix} 1 + D_{5} T^{*} \end{bmatrix}$$
Pressure Strain Rate Effects

Gruneisen
Equations of State

$$p := \left[ \frac{\rho_{0} \cdot C^{2} \cdot \mu \cdot \left[ \left[ 1 + \left( 1 - \frac{\gamma_{0}}{2} \right) \cdot \mu - \frac{a}{2} \cdot \mu^{2} \right] \right]}{\left[ 1 - \left( S_{1} - 1 \right) \cdot \mu - S_{2} \cdot \frac{\mu^{2}}{\mu + 1} - S_{3} \cdot \frac{\mu^{3}}{(\mu + 1)^{2}} \right]^{2}} \right] + \left( \gamma_{0} + a \cdot \mu \right) \cdot E$$







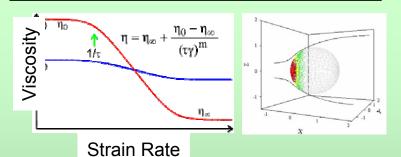


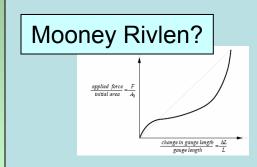




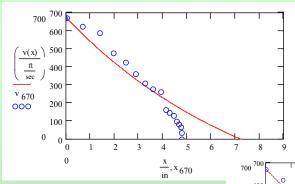


- Poncelet/Peters/Sturdivan
- •Forces Involved:
  - ·Inertia
  - ·Viscous
  - Strength
- Boundary Layer (Thixotropic)
- •Hyper Elastic Solid or Fluid? ... YES





- ✓ Non-linear elasticity
- ✓ Strain rate dependant
- Viscous flow

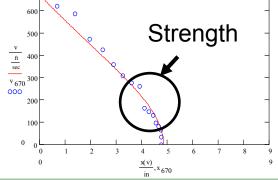




Hyper-elastic

Penetrating at High Velocity

Penetrating at Low Velocity









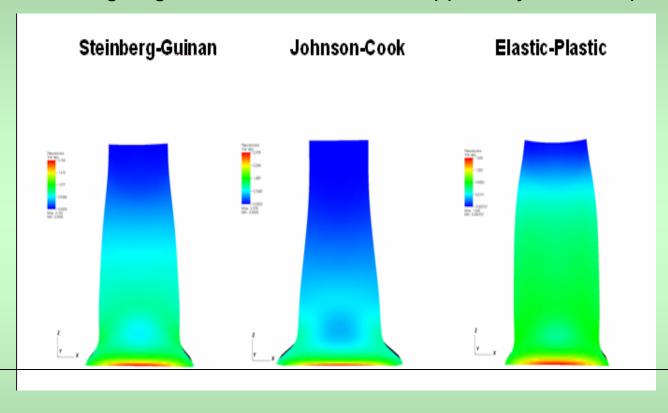
#### Material Models; choose wisely

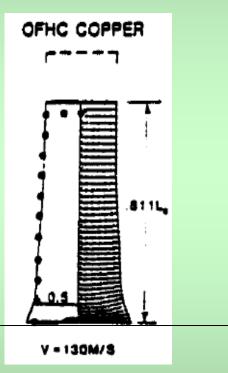






#### Three Lagrangian material models of copper Taylor-bar impact





Test data

Correlate to test data whenever possible

Proper stress/strain accumulation & failure mechanisms













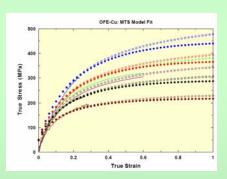


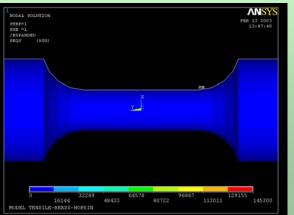
#### Copper "Gilding Metal"

**Lead Antimony** 

Steel(s)

Gelatin; 10% vs. 20%



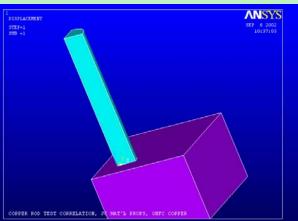


## $\sigma_{\mathbf{v}}$

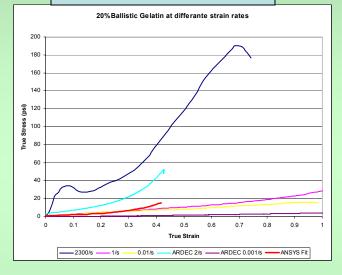
#### $\epsilon_{\mathbf{f}}$

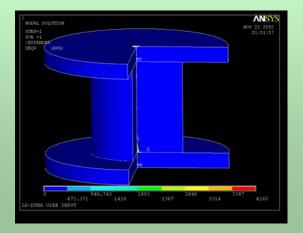
- 1. Strain Hardening
- 2. Strain Rate
- 3. Temperature
- 4. Pressure
- 5. Viscosity?





# Material property characterization (ARDEC/ARL/OGA)











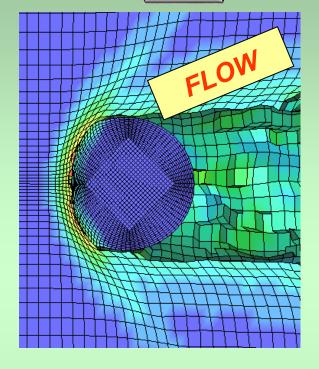
#### Largest Challenges

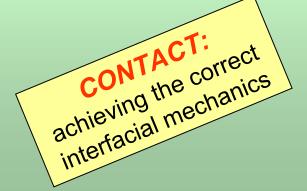


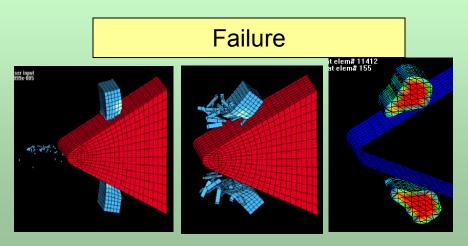




- Conservations of Mass
- "Conservation of Geometry"
- Material Failure
- Gelatin; Fluid or Hyper-elastic Solid?
- Time/Displacement













#### Lagrangian vs. Eularian vs. Particle



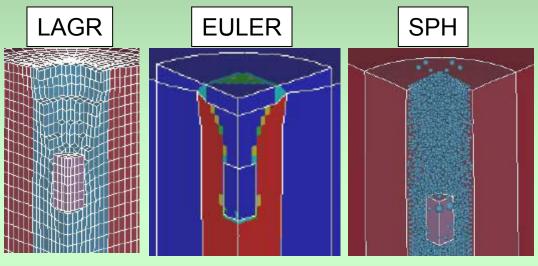




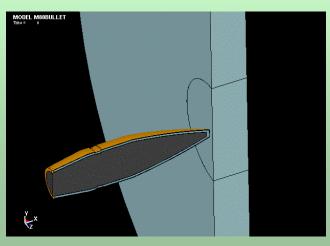
#### •Pros/Cons

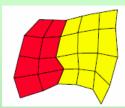
- •LAGR, EULER, ALE, SPH
- Connectivity (and lack there of)
- "Conservation of Geometry"

#### **Concrete Penetration Simulations**

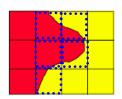


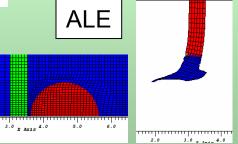
#### M80 ball at V50





















#### Results of ARDEC work-to-date







## Rigid Body, Low Velocity

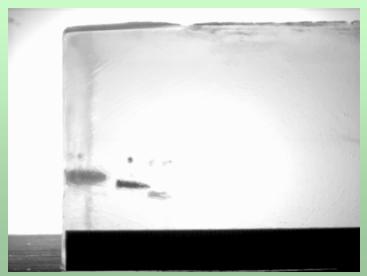


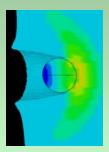




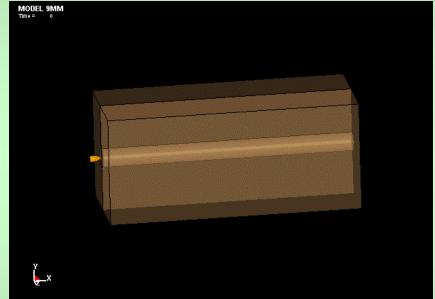
#### Steel BB







- √ Stagnation pressure
- √ Velocity decay
- √ Elastic response





Pistol; FMJ Ball Ammo





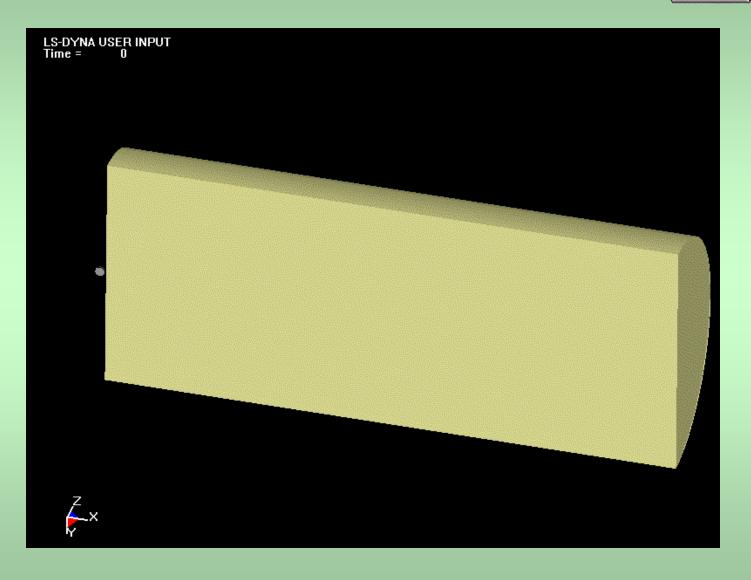


## Rigid Body, High Velocity













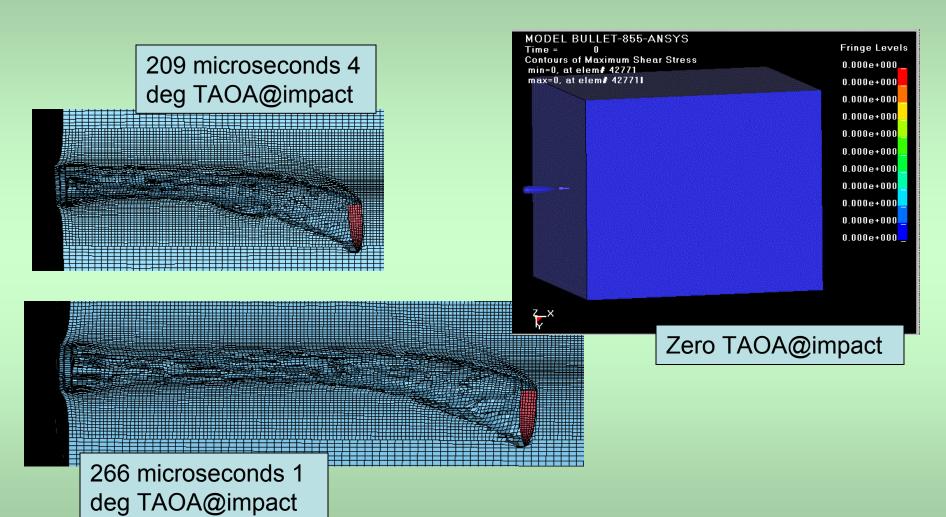


#### Rigid Body High velocity with Yaw















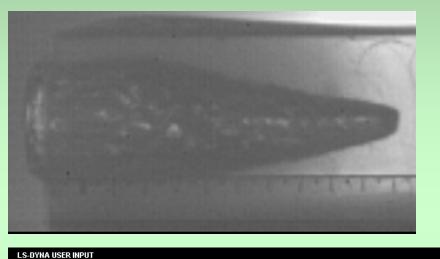
## Deformable Projectiles





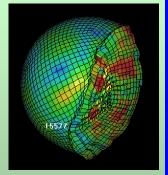


#### 0.75 caliber musket ball impacting 20% gelatin at 1028 fps

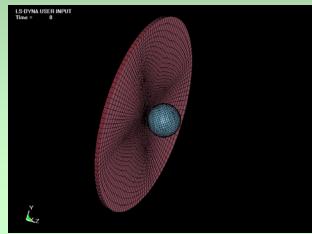




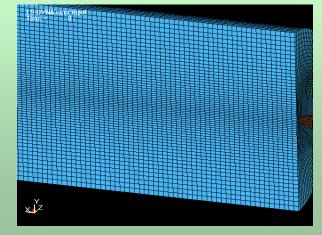
Deformed Lead 75cal Ball



Lead Ball; LAGR



Solid Lead Projectile; ALE











## Fragmenting Projectiles

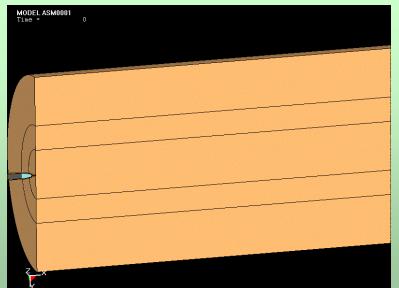




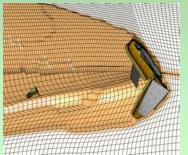


#### M855 impacting 20% gelatin at ~2800 fps



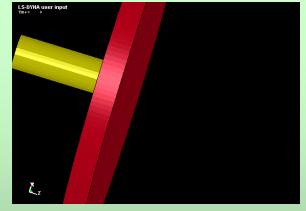


Real-Time Yaw, Deformation, and Fragmentation





ALE Lead vs. LAGR Steel



- √ Stagnation pressure
- √ Velocity decay
- ✓ Elastic response



#### Applied What-If's





- Geometry
  - ✓ Cannelure
  - Boat-tail
  - Jacket thickness
  - Core construction
- Materials
  - ✓ Hardness
  - Density
- Connectivity
  - Mechanical Interface
  - Bonding

#### **MASS**

**VELOCITY** 

**CONFIGURATION** 







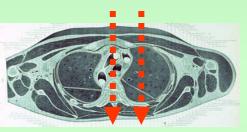
## Summary & Path Forward

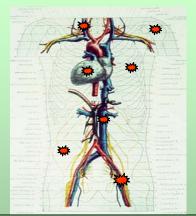
- •FEA can be a useful tool for examining the failure mechanisms of projectile impacting both "hard" and "soft" targets
- •FEA analysis may be used to augment technically simpler, yet computationally larger "bulk" equation analysis techniques
- •Physics of the event to be simulated must be understood in order to properly employ material models and constituent parameters.
- •Material Model and Material Property research is critical to numerical analysis.
- •Continue searching and exercising various codes / models / parameters which best accomplish the missions requiring this level of technical support











Multiple Material
Properties on single
shot-line

# ARDEC Rapid Design Projects for Field Support – Part 1

L-Bracket for use with M240B Medium Machine Guns on HMMWVs with Gunner's Protection Shield (NSN 2510-01-498-4996)

Michael Narus
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NDIA Speaker

**Robert Mulfinger** Mechanical Engineer **Anthony Cautero Lead Engineer - Mounts** 

## Objective

- Tasked by PM Soldier Weapons and ARDEC's Quick Reaction Task Force to make AN/PEQ-2A aiming laser useable on the M240B with HMMWV Gun Shields
- Issue was brought to ARDEC's attention in October of 2005 by the 4<sup>th</sup> Infantry Division prior to deployment.
- Fix was needed in time for deployment in Dec 2005.

## Gun Shield with M240B



## **Problem Statement**

Shield blocks any aiming laser mounted on forward rails.







## **HMMWV** Gun Shield Information

- Intended for use with MK19 GMG, M2 .50 Cal and M240B MMG
- Mounts on roof of HMMWVs
- Provides gunner with front and some side protection



## AN/PEQ-2A Information

- Aiming laser used for small arms
- Has one aiming laser and one illuminating laser with adjustable focus
- Emits only invisible IR light
- Powered by two AA batteries



## M145 & TWS Information

- M145 fixed 3.4 power Machine Gun Optic (MGO)
- AN/PAS-13 Thermal Weapon Sight (TWS)





## Concepts

- Modify gunner's shield
- Readily available commercial solutions
- Mount extension on top rail (L-Bracket)





## Commercial Bracket Evaluation

- Evaluated by 4<sup>th</sup> ID and 29<sup>th</sup> IR
- Increases height of optic from weapon
  - Exposes gunner
  - Non existent cheek to stock well; neck strain (poor eye relief and sight picture)
- Requires new offset targets for all sights

Conclusion: AN/PEQ-2A still interferes with back of gunner's shield.

## L-Bracket Prototypes







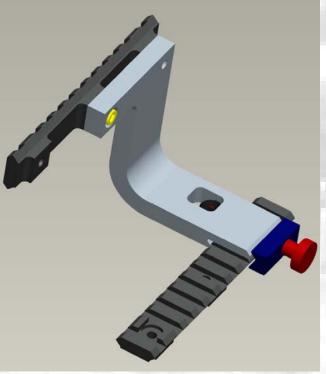
## L-Bracket Evaluation

- AN/PEQ-2A is mounted relatively close to weapon
  - Maintains position of all optics on M240B machine gun feed tray cover rail
  - No new target offsets for optics
  - Reduces possibility of damaging weapon and optic
  - Brings aiming and focused flood light above shield
- Firing done from tripod and HMMWV
- Road test done with HMMWV
  - No cracks, no loss of zero, no screws loosening

Conclusion: Concept solves issues, is durable and reliable.

## **FABRICATION**

- 880 Brackets required for 4<sup>th</sup> ID
- Design finalized and refined for manufacture at Picatinny Rapid Prototyping Facility
  - Parts to be cut from sheet metal stock
  - Rail grabber features machined
  - Parts bent to create 90° angle
- Standard parts ordered (screws, washers, etc.)
- Rails ordered from spare part system
- Offset targets created for AN/PEQ-2A
- Installation instructions created
- Assembled and packaged



#### Schedule

- 6 October 2005 Work Began
- 27 October 2005 L-Bracket Testing
- 9 November 2005 Production Began
- 22 November 2005 First Shipment
- 6 January 2006 Last Shipment

## Fielding

- 880 L-Brackets shipped (Nov 2005 Jan 2006)
- 700 additional L-Brackets shipped (March 2006)
- Users satisfied with solution
- No need to improve solution
- Additional Brackets are being procured



# ARDEC Rapid Design Projects for Field Support – Part 2

# The M113A2 Armored Personnel Carrier (APC) Degtyarev-Shpagin (DShK) 12.7mm Heavy Machine Gun (HMG) Mount

Joseph P. Chiarolanza Mechanical Engineer U.S. Army ARDEC Picatinny Arsenal, NJ (973) 724-7069

jchiaro@pica.army.mil

**NDIA Speaker** 

Michael Narus Mechanical Engineer **Anthony Cautero** Lead Engineer - Mounts

### Objective

Tasked by U.S. Army Tank Automotive Command (TACOM) and the Afghanistan Office of Military Cooperation (OMC-A) to design, fabricate, and ship a quantity of 63 mounting platforms to interface the DShK 12.7mm HMG to the M113A2 APC in support of the Afghanistan National Army (ANA).

### M113 Background Information

- Units produced (of all variants): ~80,000
- Crew: 2 + 11 used primarily as a battle taxi
- Weight: 12.3 tons
- Armor: Aircraft quality aluminum
- Main armament: M2 0.50 Caliber HMG
- Road Speed: ~41 mph
- Range: ~300 miles
- A2 Variant introduced in 1979 and features cooling and suspension improvements

Reference: Jane's Military Vehicles and Logistics 2005-2006

## DShK / M2 0.50 CAL HMG Background Information

	<u>DShK</u>	<u>M2</u>
<ul> <li>Ammunition</li> </ul>	12.7mm x 107	12.7mm x 99 (.50BMG)
<ul> <li>Muzzle Energy</li> </ul>	15,570 J	16,876 J
<ul> <li>Weight, empty</li> </ul>	35.7kg (78.5lbs)	36kg (79.2lbs)
<ul> <li>Cyclic ROF</li> </ul>	575-600 spm	550 spm
<ul> <li>Date of Design</li> </ul>	1938	1921
<ul><li>Action</li></ul>	Gas	Short Recoil
<ul> <li>Variants</li> </ul>	DShK38, DShKM	M2HB

Reference: Jane's Infantry Weapons 2005-2006

#### **Problem Statement**

DShK



The ANA needed to modify the existing weapon platform on the M113A2 APC in order to mount the DShK Soviet 12.7mm machine gun.

M2 0.50 cal HMG

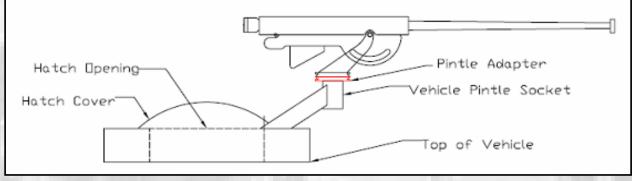
**DShK Cradle & Pintle** 

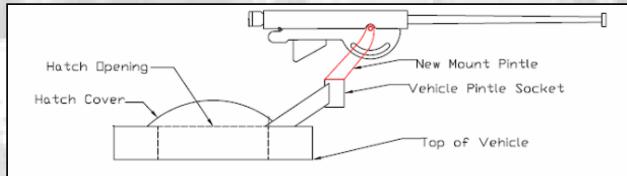


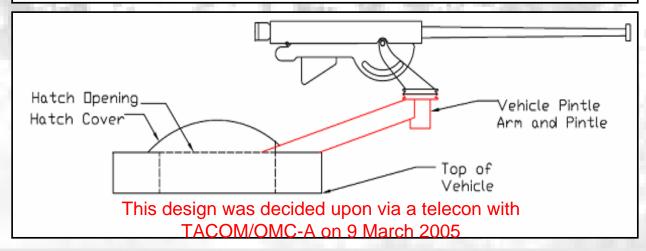
## User Design Requirements

- Reduce gunner's exposure by lowering weapon height
- Allow mount to clear all obstructions when rotating turret
  - Including open driver's hatch
- Extend pintle centerline outward thereby reducing weapon interference with gunner
- Maintain weapon elevation of at least 25°
- Allow for proper bottom ejection of spent cartridge cases
- Limit periscope view obstruction
- Maintain ability to dismount weapon

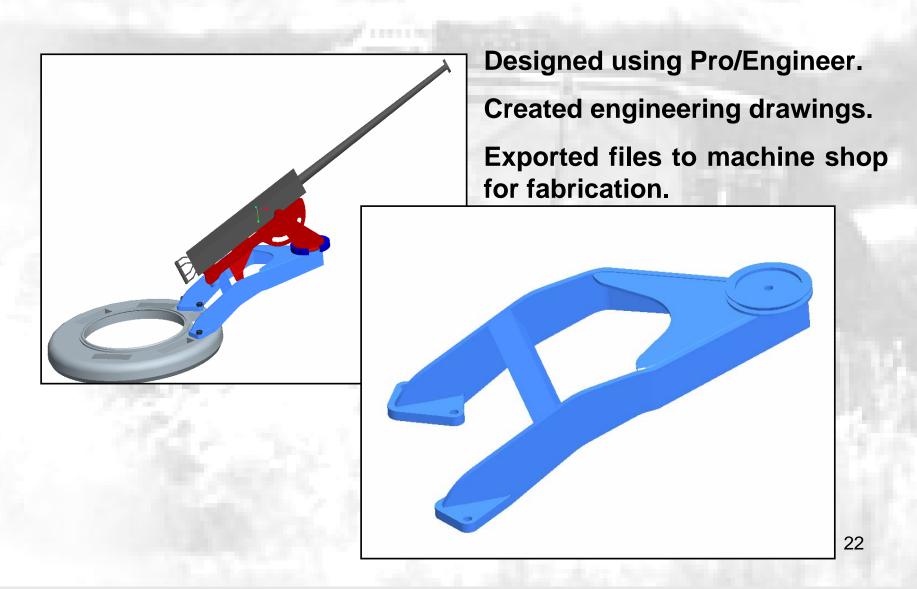
## Design Ideas







## Final Design Concept



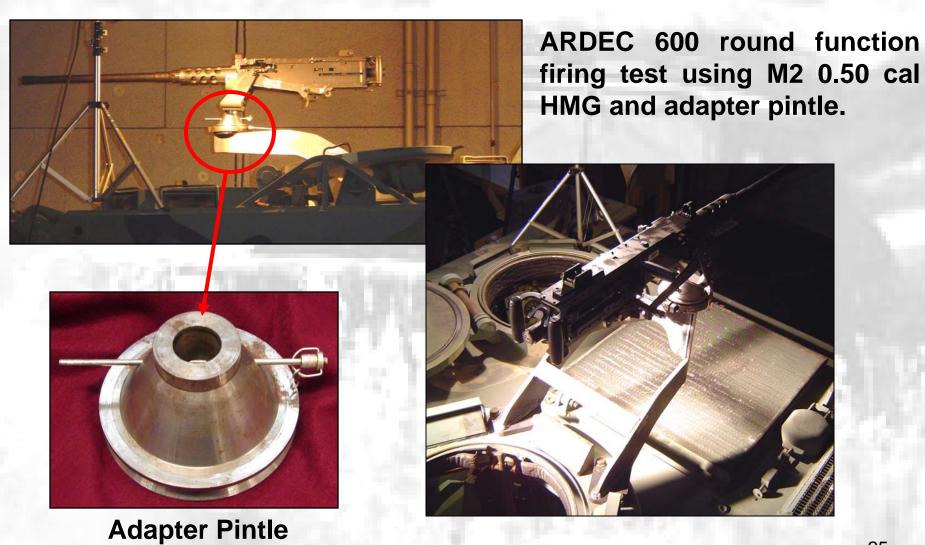
## Initial Prototype



### Testing

- 600 Round ARDEC function firing test using M2 0.50 cal HMG and pintle adapter
- Modeling & Simulation at ARDEC using MSC-NASTRAN simulating mount to typical 3000 mile M113 driving loads IAW MIL-STD-810 program data
- Validate M&S at ATC on vibration tables subjecting mounts to the same loads as above

## Testing



## Testing



Aberdeen Testing Center Vibration Table Setup

### Fielding/Feedback Issues

- Confirmation that ANA received mounts on 21 Feb 2006.
- Awaiting user operational feedback.

## Schedule

M113 APC DShK 12.7mm Mount	FY05 FY06														
MILESTONE	0	N	D	J	F	М	Α	M	J	J	Α	S	0	N	D
DShK Cradle Available to ARDEC															
Program Approval, Funding															
Design Concepts Created and Presented															
Customer Feedback and Concept Down Select															
Create Pro-E models, 2-D Shop Level Drawings															
Fabricate metal prototype, Verify Form/Fit/Function															
Modeling and Simulation; FEA Analysis															
Test Firing with M2 .50 Cal machine gun															
ATC 3000 Mile Vibration Test															
Improve design based on results of FEA and vibration test															
Finalize drawing package															
Begin production															
Deliver first lot (24 units)															
Deliver second lot (39 units)															

## Questions?



# UPDATE ON NATIONAL SMALL ARMS CENTER

Frank P. Puzycki Research Program Director

17 May 2006



## AGENDA

- Intent
- Progress
  - Requirements
  - Awards
  - Membership
  - Communication
- Issues
  - International Structure
  - Funding



#### NSAC/NSATC - INTENT

- A Virtual Center Headquartered at US Army ARDEC
- A Consortium of <u>Industry/Academia/National Labs</u> (NSATC) operating under:
  - A Consortium Member Agreement (CMA) and
  - An Other Transactions Agreement (OTA)
- Agenda Driven by the Joint Service Small Arms Master Plan
  - Built Upon the Transformation Strategies of the Services
  - Supported by Joint Small Arms Capability Based Analysis
- Principally to Give More Visibility to the Need for Greater Resources for Small Arms Technology



- NSATC is a Self Governed Organization
- Organized Under the Aegis of the National Cooperative Research and Production Act (NCRPA) of 1993 as Amended
- Has Limited Civil Anti-trust Liabilities if Registered with the Federal Trade Commission and Department of Justice
- NSATC Registered on 4/7/04
- OTA For Prototyping Authorized by Section 845 of the 1994 National Defense Appropriations Bill, as Amended

## How It Differs

- Other Transaction Agreement (OTA) Driven Process
  - Requires USG to Stipulate Desired <u>End Results</u>
  - Allows Consortium Members to Propose the How's, When's and Cost's
  - More Open Negotiations
  - More Innovative Solutions
  - Non-traditional Industries/Academe Influences

## What It Is!

- Industry/Academia
- · Centric
- Innovation
- Center



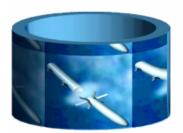
#### REQUIREMENTS

- First white paper cycle completed in August 2005
- Impacted Joint Small Arms Capability Analysis
- Aided in redefining nine affinity groupings

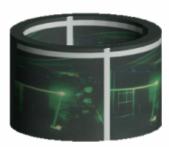


#### THRUST AREAS

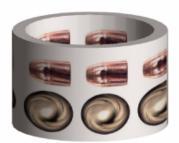
#### **Affinity Groupings**



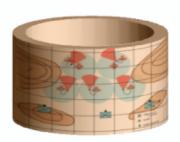
**Smart Munitions** 



Technical Fire Control



Materials & Processes



Modeling & Analysis



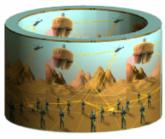
New Concepts and Applications



Warheads & Energetics



Lethality & Utility



**Tactical Fire Control** 



**Weapons Mechanisms** 



#### REQUIREMENTS

- Request for Business Development Proposal Initiative Launched
  - Twenty-six proposals received and evaluated by a multi-service/agency team
  - Defined 10 new avenues of investigation under the JSACA
  - Referred to Business Development Committee for Marketing
  - NSAC marketing to in-house PM organizations

## Awards

- Seven Awards in FY05 Totaling \$3.3M
- Seven Awards in Process for FY06
- Potential for a minimum of 3 additional awards this fiscal year
- Loss of Charter Grants-Officer
- Negotiations phase remains the wild card of this OTA based process



#### FY 05/06 AWARDS

Lighter and Smaller Crew Served Weapons	Barrett Firearms	\$766,350
Recoil Mitigation & Energy Conversion	Cape Aerospace	\$261,000
5.56mm Polymer Cartridge Case Development	Mississippi Polymer Technologies	\$250,000
5.56mm Polymer Cartridge Case Development	Polytech Ammunition Co	\$750,016
40mm Low Recoil Weapon System	FN Herstal	\$443,000
25mm Lightweight Composite Barrell Development	MER Corp	\$130,000



#### FY 05/06 AWARDS

Lubeless Weapon Coatings Development	Integran Corp	\$235,000
Lubeless Weapon Coatings Development	ATFI	\$235,000
Lightweight 7.62mm Ammunition Study	Fleximation	\$71,488
Thinwall Cartridge Case for 7.62mm Ammunition Effort	SNC TEC	\$784,794
Lightweight 7.62mm Ammunition Study	Frontier Performance Polymers	\$87,154
Lightweight 7.62mm Ammunition Study	Mississippi Polymer Technologies	\$79,958



#### Membership

- FY05 Membership (9 months) increased from 27 to 52 members
- FY06 Membership increased by 10 to date
- University-outreach program
  - Local based schools
  - Targets of opportunity
  - Extended Reach
  - "Walk-ups"



### Membership Demographics

- Weapons Systems
   Developers/Producers
- Ammunition & Energetics Producers
- Materials and Coatings Specialists
- Research Institutes & Universities
- Manufacturing Specialists
- Engineering Services Firms
- Electro-optical specialists



#### Membership Process

- Applications available on-line at NSAC website
  - Application
  - Consortium Member Agreement
  - Background Information
- Contact Executive Director or Research Program Director directly



#### Points Of Contact

- Frank P. Puzycki (Research Program Dir)
  - 973-724-6081
  - frank.puzycki@us.army.mil
- Barbara Byrnes (Executive Director- NSATC)
  - **703-212-8030**
  - bjbeme@aol.com



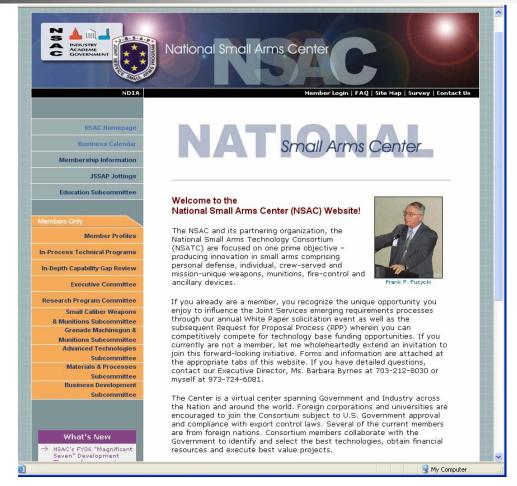
#### Communications

- Still in teething pain stage
- Webpage has proven to be a major plus
  - "How To" articles
  - JSACA Developments
  - USMC IAR Advanced Draft of SOO
- Webpage to be augmented by Collaboration Software Suite
  - Present Issues to Membership
  - Brainstorm in the Virtual Environment
  - Unexpected uses



# National Small Arms Center Website





http://www.pica.army.mil/nsac/



#### ITARS

- Created difficulties on extant contracts
- Will impede information sharing possibilities in the future
- Seeking some form of Omnibus Relief from State Department or other innovative approaches toward a "One size fits all" alternative



### Funding

- Our reputation creates OPM opportunities
- JSSAP making headway in expending Tech Base Steady State Funding Increases
- Marketing RBDP proposals within and external to ARDEC to augment smallarms unique research
- We are gaining traction and developing the compelling story



## **SUMMARY**

- Active programs in lubeless weapon technology, lightweight cartridge cases and recoil mitigation in progress
- New start effort USMC IAR Program
- Membership continues to expand
- Funding augmentation being aggressively pursued









#### Contact:

Darold Griffin / Barbara Byrnes 703-212-8030 EME1BMT@aol.com

## US ARMY SMALL ARMS UPDATE



**COL Robert Radcliffe Director, Combat Developments US Army Infantry Center** 



## Post Combat Survey Trends Individual Weapons



#### M4 comments:

- Soldier ratings highly positive and increasing
- Preferred weapon due to compact size and modularity
- Some problems with magazine reliability

#### M249 SAW comments:

- Soldier ratings moderately positive and increasing
- Soldiers like its high rate of fire and target effects vehicle/personnel
- Soldiers like the SAW improvements: shorter barrel; collapsible stock
- Weapon age has created reliability, durability, & maintainability issues significant overhaul program underway

#### M203 comments:

- Soldier ratings moderately positive but decreasing
- Need better sights day & night

Trigger and safety very susceptible to failure from sand/dust/dirt

#### M9 Pistol comments:

- Soldier ratings neutral and decreasing
- Pistol & magazines have frequent malfunctions
- Does not have enough "stopping power"
- Sights are inadequate

3300 Soldiers 8 Divisions Active, Guard, Reserve



# Post Combat Survey Trends Crew-served Weapons



#### M240B Medium Machine Gun comments:

- Soldier ratings consistently highly positive
- Great rate of fire and target effects
- Good durability

#### M2 Heavy Machine Gun comments:

- Soldier ratings consistently highly positive
- Great performance; durable and reliable
- Failures due to improper headspace & timing

#### Mk19 Grenade Machine Gun comments:

- Soldier ratings moderately positive but decreasing
- Great weapon in open terrain
- Limited in the close urban fight (ROE, arming distance, dud rates)

#### Sniper weapons comments:

- Soldier ratings highly positive
- M24 -- need higher rate of fire
- M107 effective; heavy; needs improved scope & suppressor



### **Overall Small Arms Strategy**



#### Train the force

- Sustain increased frequency and realism of training
- Resource training support and facilities

#### Sustain the current small arms fleet

- Resource rebuild & refurbishment to sustain the current fleet
- Produce weapons to fill wartime and transformation needs
- Product improve existing systems as able

#### Modernize the force

- Develop the next generation of weapons and ammunition
- Accelerate new systems when ready



## **Weapons Development Strategy**



Near Term (0-2 years)
Sustain through
refurbish/rebuild,
product improve,
leverage off-the-shelf
technology





Increase M4 Issue



Grenade Launcher



Mid Term (2-5 years)
Modernize by spiraling
new systems against
key gaps, initiating a
common approach

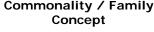




Far Term (5+ years)
Integrate new
technologies; reduce
Soldier load, improve
lethality, and improve
small unit flexibility









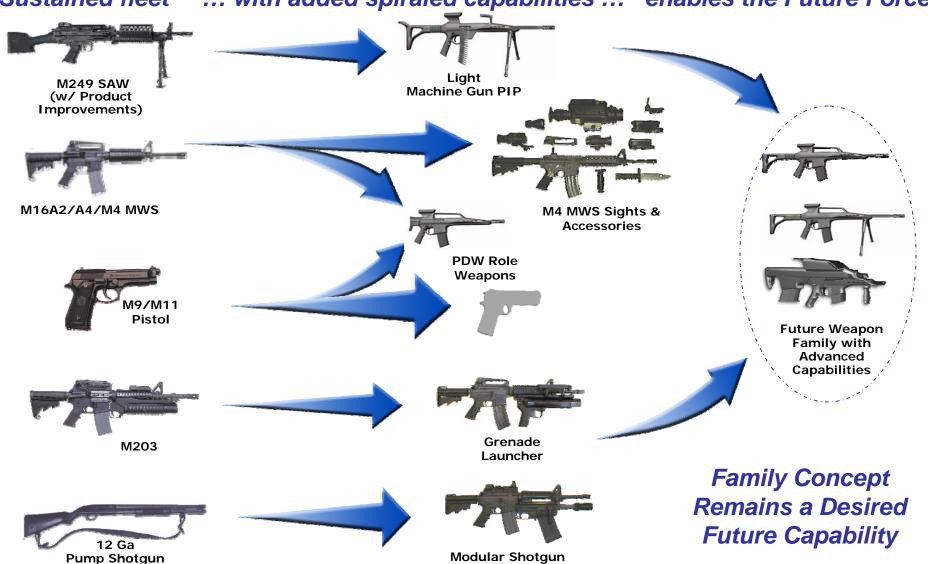
Light Weight Small Arms Technology ATO (Caseless/CTA Ammo)



## **Individual Small Arms Strategy**

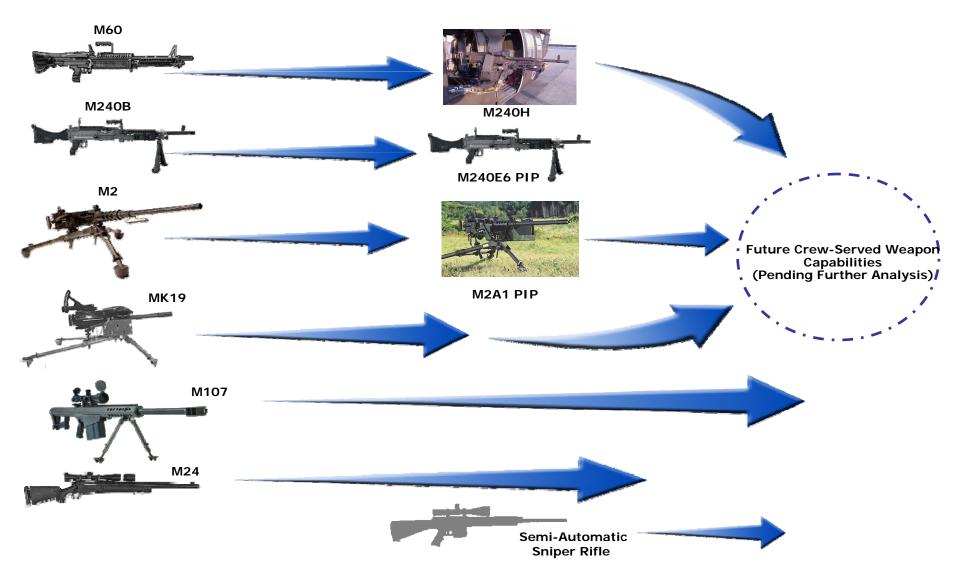


Sustained fleet ... with added spiraled capabilities ... enables the Future Force.











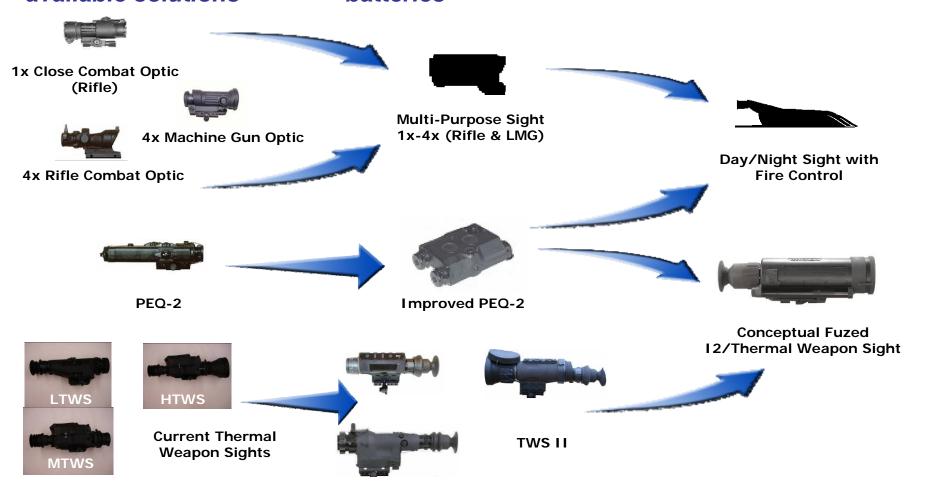
## **Small Arms Sight Strategy**



Near Term (0-2 years)
Sustain: Field existing
& commercially
available solutions

Mid Term (2-5 years)
Modernize: improved
capabilities, common
batteries

Far Term (5+ years)
Integrated capabilities,
improved power sources





## **Small Arms Ammunition Strategy**

## Near Term (0-2 years) Assess off-the-shelf solutions

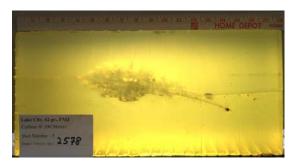


Commercial 5.56mm Assessment



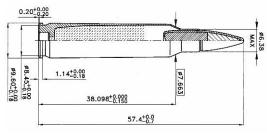
M1001 40mm Flechette

#### Develop better science



Joint Service Wound Ballistics Studies

# Mid Term (2-5 years) Product improve within existing ammunition



5.56mm PIP



40mm PIP, 40mm Breaching Munition



XM1022 .50 sniper

# Far Term (5+ years) Improved performance, longer range & lighter weight systems



**Bursting Munitions** 



**Extended Range Non-lethal Munitions** 



Light Weight Technologies





#### **Areas of Interest**

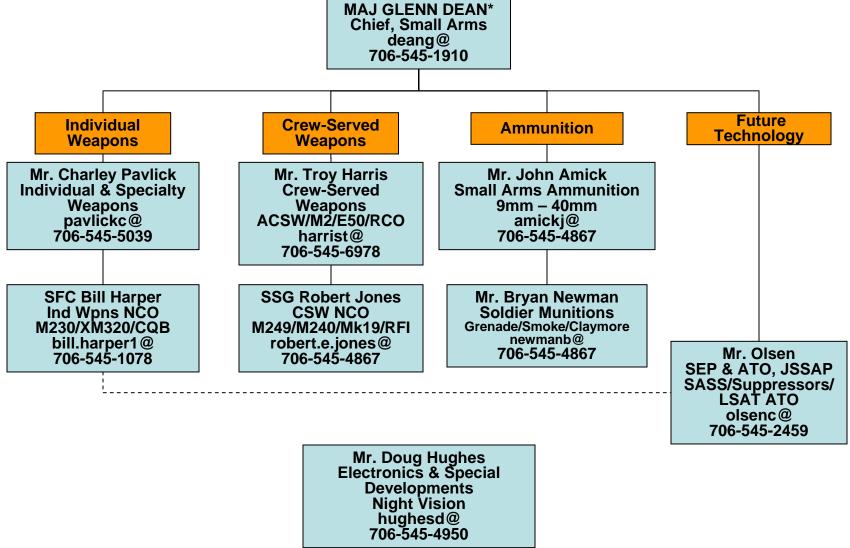
- Weapon Product Improvement
- Sights & Fire Control
- Suppressors
- Personal Defense Weapons
- Counter-Defilade Technologies
- Sniper Accessory Kit Items
- Reduce Size, Weight, Power





### **Points of Contact**







# M107 .50 Caliber COTS/NDI Sound Suppressor Evaluation







Joshua Semick, US Army ARDEC





## Objectives

- Debrief demonstrated performance of M107 .50 caliber suppressor samples submitted for government bid sample testing.
- Review general shortcomings, positive performance areas, and soldier feedback.
- Observations on suppressor design and affect on demonstrated performance





## **Test Lineup**



- Flash cross sectional area measured using high speed photography
- Sound peak SPL recorded using digital oscilloscope at five (5) positions
- Muzzle Blast ground disturbance area below suppressor
- Recoil recoil energy (ft-lbs)
- Accuracy/Dispersion five 10 round targets at 500 meters and 1000 meters.
- Reliability 1,000 rounds per candidate, stoppages and failures were recorded
- Limited User Evaluation Army and Marine Snipers





## Flash (baseline)







## Flash – Candidate Suppressor

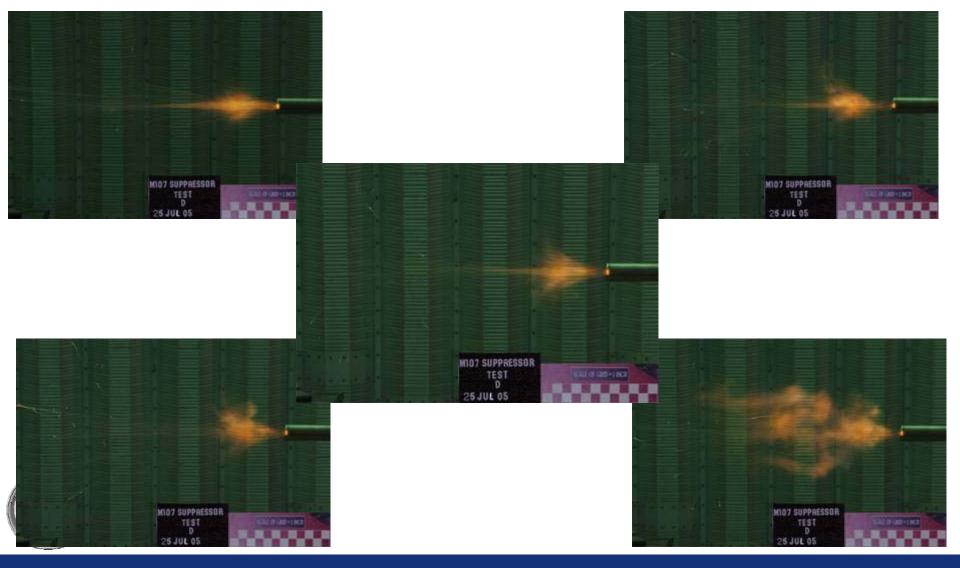






## Flash – Candidate Suppressor

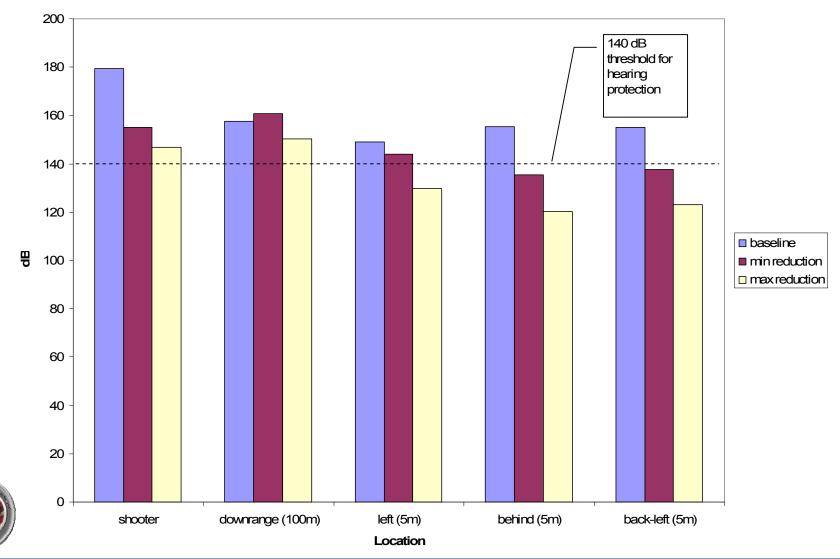






#### Peak Sound Pressure Level vs. Location







## Reliability



- Overpowering changed the dynamics of the "well tuned" M107 baseline system increasing operating group velocities and stresses
- Broken extractors and cracked charging handles were common
- Frequent stoppages (FFD, FXT)
   experienced during TT and by Soldiers
   during LUE





## User Evaluation Feedback



- Recoil level in excess of 45 ft-lbs reflected negatively
- Blowback
- Muzzle heavy situations reported above 5 lbs
- Quick attach/detach a must



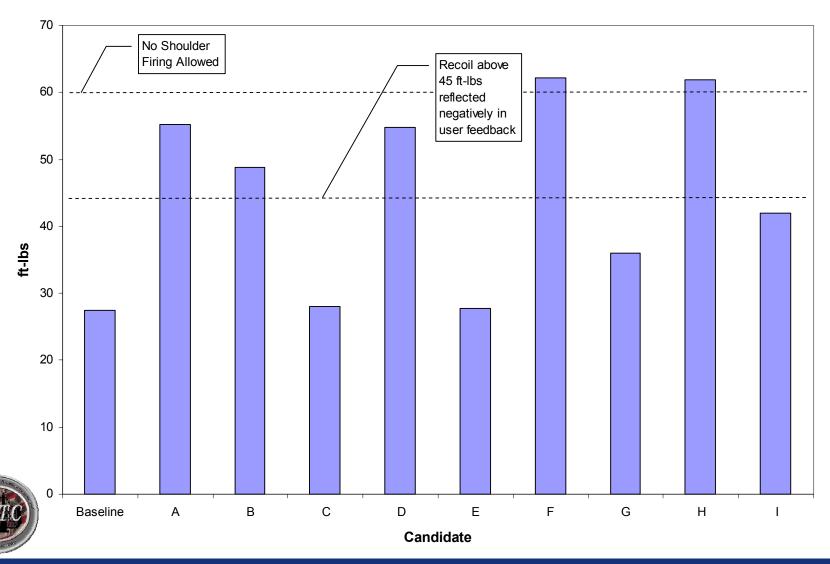






#### **Recoil Energy**







## **Shot Sequence**



1. 2.



3. 4.

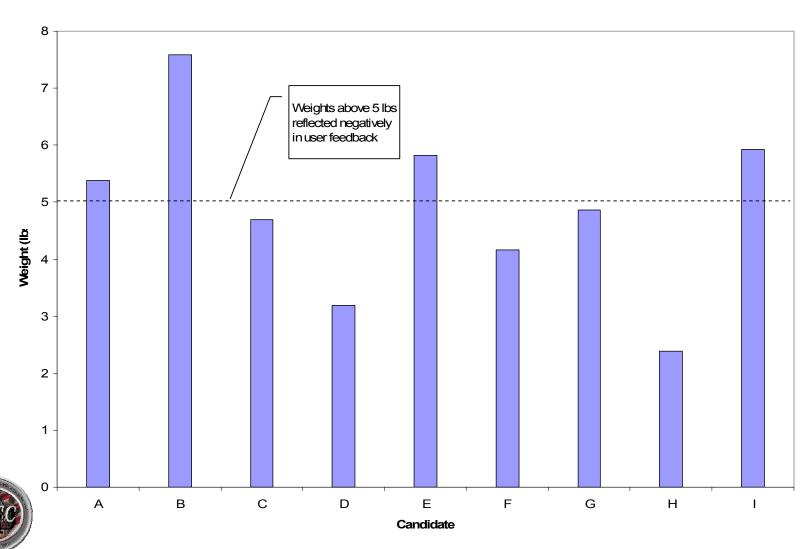






#### **Suppressor Weight**







## Observations



- Drastic increases in recoil energy produced an overpowering situation resulting in stoppages and premature component failures.
- Expansion tank designs generally produced more blowback than designs that shifted sound frequency outside of the audible frequency range.
- Designs that shifted sound frequency produced excessive recoil energy levels.







## 7.62mm, Lethal Limited Range Round (L<sup>2</sup>R<sup>2</sup>) (US Coast Guard)

**NDIA 2006** 

Prepared by:

Chad Sensenig
Small Caliber Ammunition US Army,
ARDEC

Sung Chung
Aeroballistics US Army, ARDEC









Design, develop, and demonstrate a 7.62mm Lethal Limited Range Round (L<sup>2</sup>R<sup>2</sup>) to meet the unique needs and requirements of the US Coast Guard for use in harbor security applications. This ammunition will be fired from mounted 7.62mm, M240 Machine Guns or M14 rifles and will be capable of engaging and defeating a variety of seagoing vessels and personnel targets while reducing maximum range to minimize collateral damage to the areas surrounding the locations where the round will be employed.

#### **Goals:**

- •Must function the M14 rifle and M240B machine gun with no weapon adapters / modifications.
- •Defeat 1/4 inch of mild steel set at 30-degree obliquity angle at 200 meters.
- •Effective against soft targets out to a range of at least 400 meter.
- •Maximum range of 2000 Meters (1500 Meters desirable)









#### **Previous In-house Limited Range Effort**

Caliber .50 and 5.56mm Limited Range Training Ammunition (LRTA) Programs

#### Caliber .50 LRTA

#### Requirements:

- Match M33 to 1000 meters not more than 1 mil error.
- Range not to exceed 2500 meters.
- Price not to exceed M33 cartridge.

#### Tested Designs:

- 4 designs were tested in Ft. Dix Small Caliber Test Range
  - Non-conical boat tail design.
  - Corkscrew boat tail design.
  - Straight fin design.
  - Canted fin design.

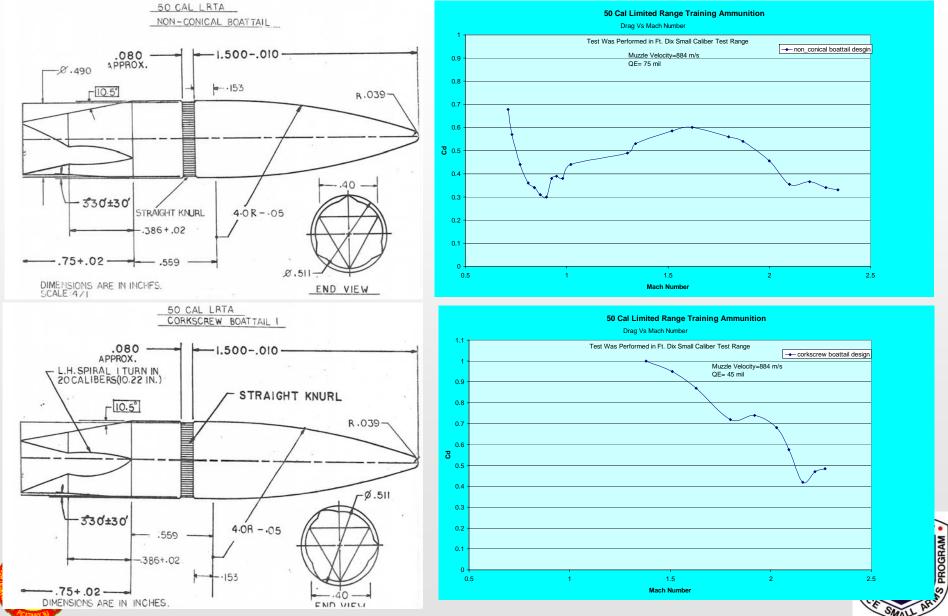






## Caliber .50 LRTA Test Results (Cd Vs Mach Numbers)

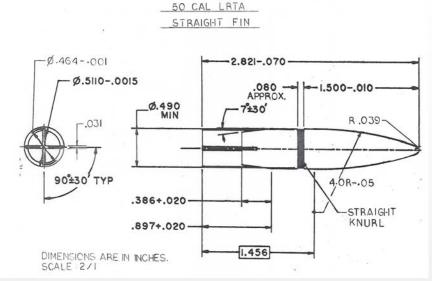


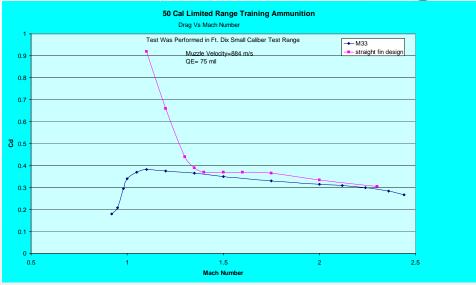


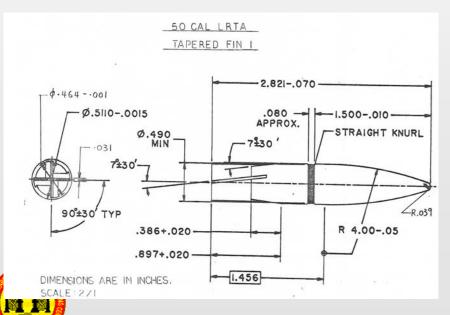


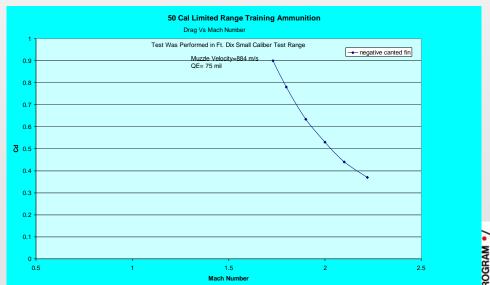
## Caliber .50 LRTA Test Results (Cd Vs Mach Numbers)















## Design Approach on 7.62mm L<sup>2</sup>R<sup>2</sup>

- 7.62mm M80 external shape with the base straight fin is chosen for the design study.
- The base fin is designed to have sufficient fin area to create instability after meeting the effective range requirement. It will also increase the drag while unstable.
- Projectile mass properties are designed to minimize the max range and optimized launch stability while fulfilling the penetration requirement.

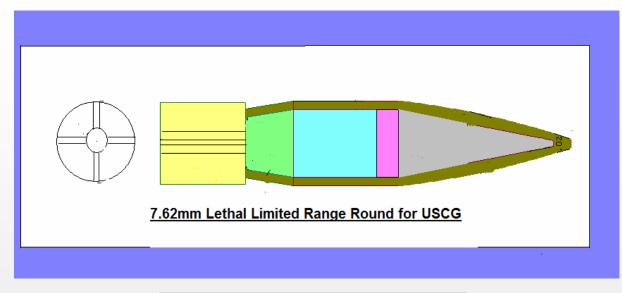






## 7.62mm L<sup>2</sup>R<sup>2</sup> Projectile Design Study Results





Case	Weight	Max QE Range	M. Vel	
	grain/lb	m	ft/s	
1	159 / .0227	2200	2508	
2	125 / 0.0179	1750	2508	
3	135 / 0.0193	1888	2508	
4	149 / 0.0210	2105	2508	
5	162 / 0.0231	2362	2508	
6	146 / 0.0208	2012	2508	

Projectile	QE	M. Vel	Weight	lx	ly	C.G.nose	Range
	deg	ft/s	grain/lb	lb-in^2	lb-in^2		m
M80	35	2850	147 / 0.021	0.0002	0.00138	0.6886	3705
M80	35	2508	147 / 0.021	0.0002	0.00138	0.6886	3548

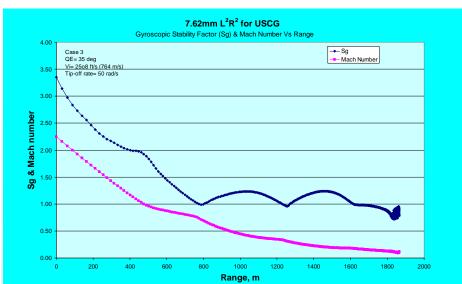


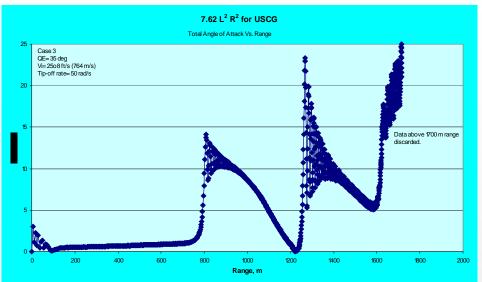


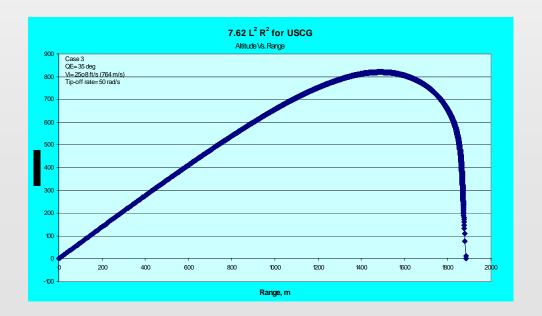


## $7.62 mm \ L^2 R^2 \ USCG \ 6\text{-Dof Trajectory Simulation}$











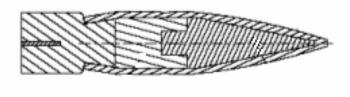


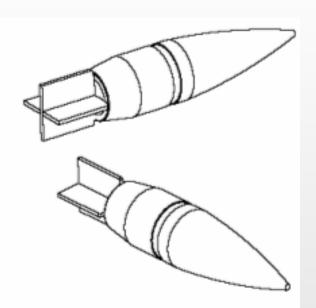




## Design of Prototype Projectile







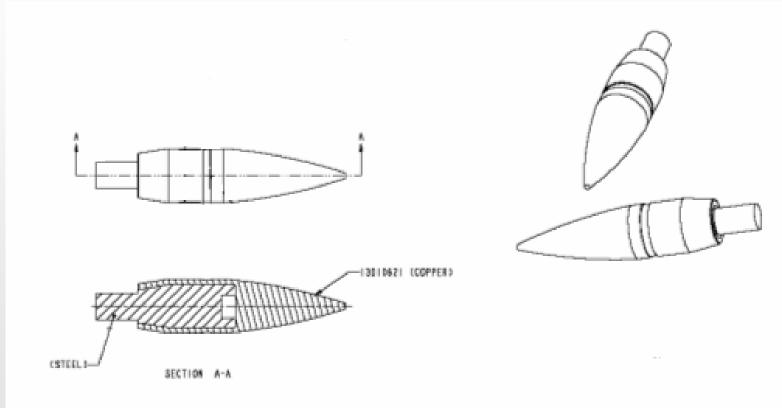








## Design of Non-Finned Projectiles











# Test I: Testing of Non-Finned Projectiles

#### Test Projectile

- Lead time shorter than finned prototypes
- Facilitated charge establishment
- Verified adequate case capacity was available
  - Occupied the same case volume rear of the cannelure
- Verified weapon function and feeding
  - Identical CG to finned projectile
  - Identical ogive to finned projectile



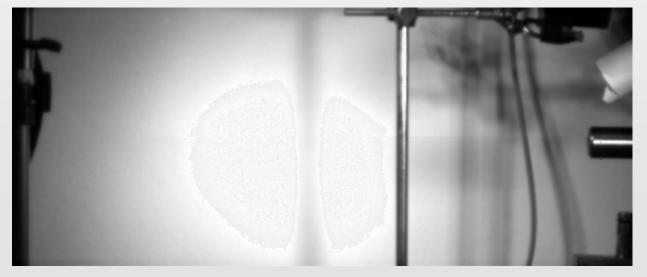




# Test II: Testing of Finned Prototypes















## Corrective Actions to Projectiles

- Tightened tolerances on:
  - Jacket and internal parts
  - Boat tail
- Applied adhesive to internal mating surfaces



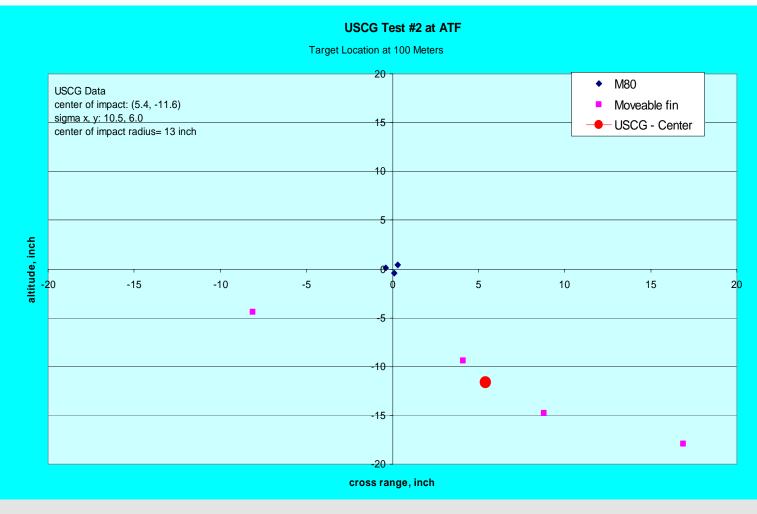




#### Test III:



## Testing of Finned Prototypes Rev. I









## Corrective Actions to Projectiles

- Tighten Tolerances on boat tail
- High speed video indicated fins were deforming at launch
  - Fin nesting redesigned
- Eliminate anodization of fins



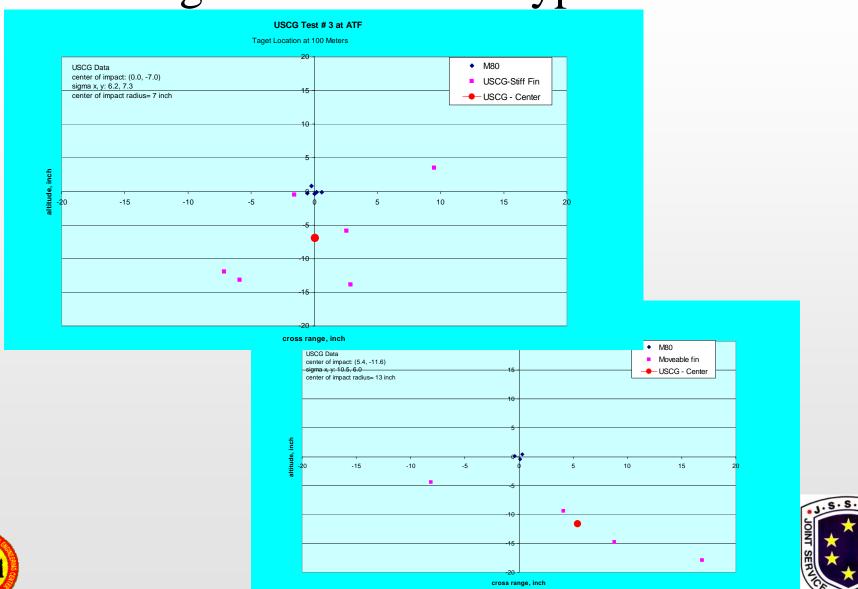




#### Test IV:



Testing of Finned Prototypes Rev. II



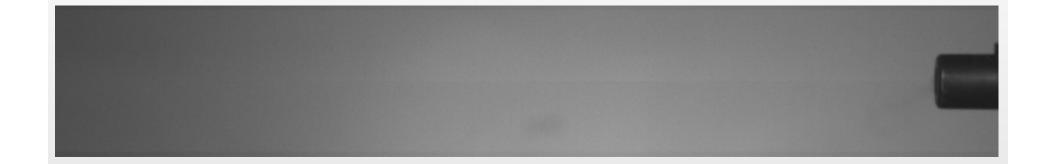








## Test IV: High Speed Video











# Test VI: Hard Target Penetration Testing

- ¼" A36 Mild Steel
- 200 meters
- 60 degree obliquity angle
- 10 Rounds fired, ALL perforated











## Summary

- Current projectile design satisfies penetration requirements
- Additional design modifications have been made to further improve accuracy
- Radar testing to verify the maximum range of the projectile has been scheduled















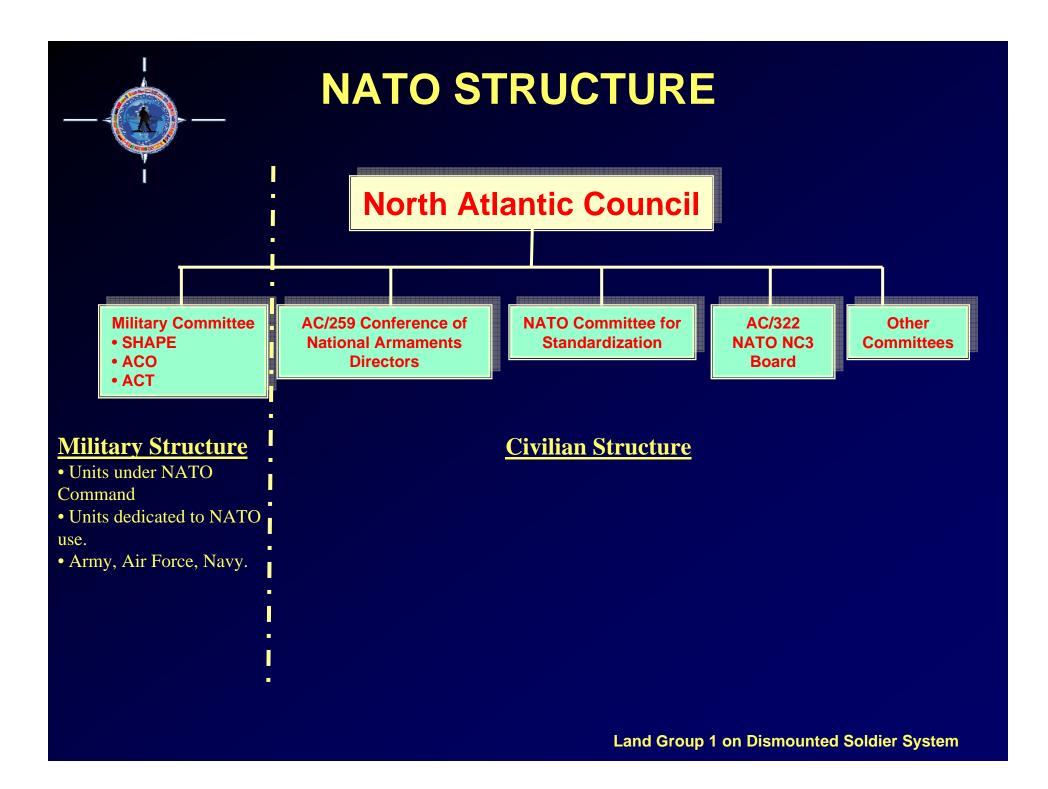
Vernon E. Shisler
Chairman NATO AC225 Land Group 1
Dismounted Soldier Systems



#### **Need to Transform**

#### Need underlined by the attacks of 11 September 2001

- Only venue for strategic coordination of transatlantic partners.
- To be relevant it must continue to serve as the foundation of the allies security
- It must be a principal international agent for stability and democratic reform throughout a wider area.
- Reform will impact NATO's:
  - Tasks
  - Membership
  - Relationship with partners, other nations and organizations
  - Ability to conduct modern military operations across full spectrum of Alliance missions





#### **Military Transformation**

- NATO Top priority
  - Streamline the command structure
  - Improve the development of military capabilities on focused critical areas.
  - Create a rapid NATO Response Force



#### **Military Transformation**

#### NATO Top priority

- Streamline the command structure
- Improve the development of military capabilities
  - Create one operational strategic command
  - Allied Command Operations (ACO)- Castreau Belgium
    - Land Based Combined Joint Task Force
    - Sea Based Combined Joint Task Force
    - Limited standing Joint Headquarters
  - Create one functional strategic command
  - Allied Command Operations (ACT)- Norfolk VA
  - Drive transformation
  - Identify needs and future capabilities
  - Work with US engine for transformation US Joint Forces Command.







#### MILITARY TRANSFORMATION

# NRF

#### **NATO Response Force (NRF)**

Previous NATO Maritime and Air Forces were by nature highly mobile, Land based assets were not.

#### **NRF = 25,000 Joint Multinational Troops**

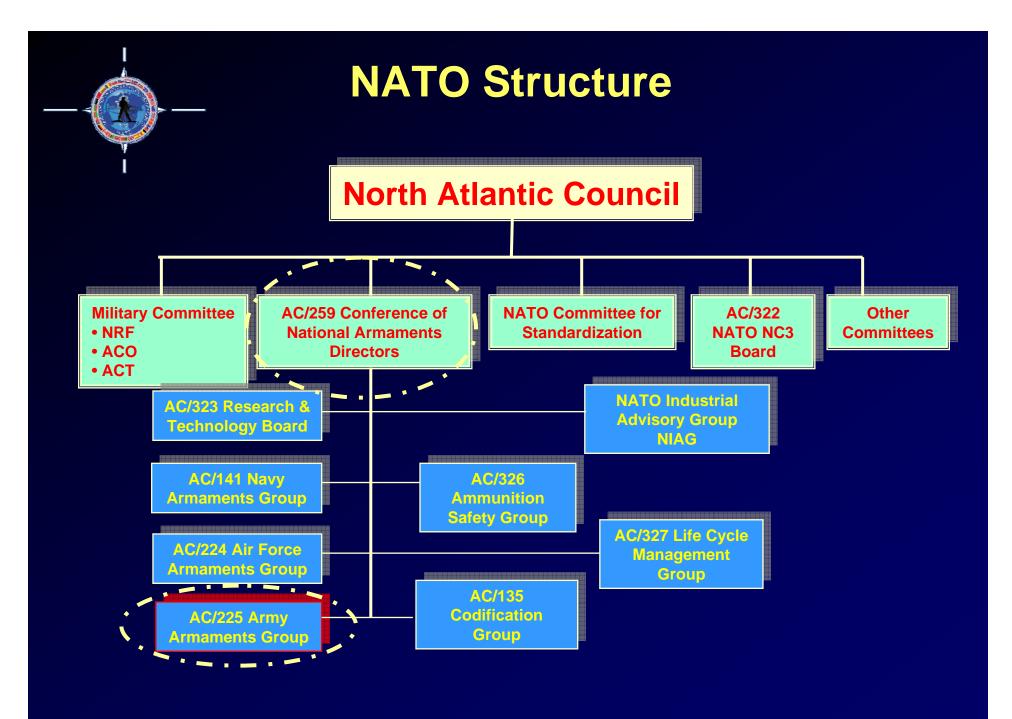
- Technology advanced
- Deployable with in 5 days
- Sustainable for 30 days
- Trained and equipped to common standards
- Initial operational capability October 2004
- Fully operational October 2006







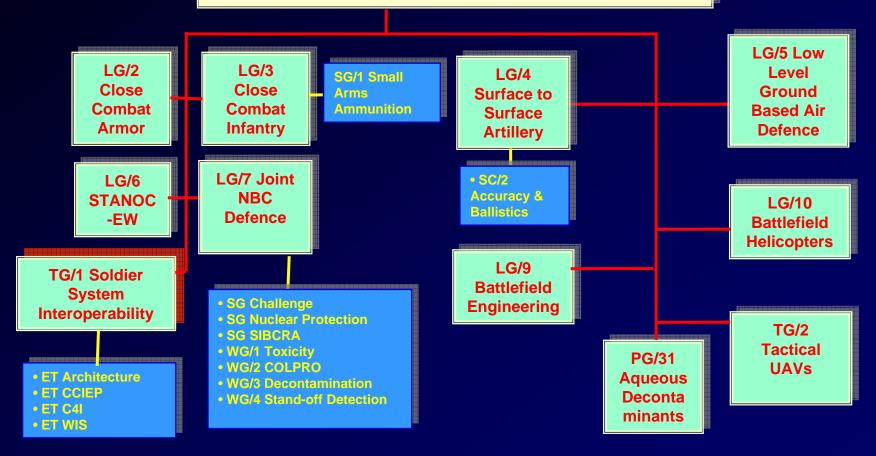






#### **Civilian Transformation**

#### **AC/225 Army Armaments Group**





#### **Civilian Transformation**

#### **Infantry Reorganization 2006**

- Create Land Group 1 Dismounted Soldier Systems
  - Utilize recourses for Topical Group 1
- Disband Land Group 3 Close Combat Infantry
  - Small Arms weapons to Land Group 1
  - Canon weapons to Land Group 2
- Move SG/1 Ammunition Interchangeability from Land Group 3 to Land Group 1
- All small arms work is now under one group with a system perspective



#### **Civilian Transformation**

#### **Council of National Armaments Directors**

- Army Armaments Group
- Navy Armaments Group
- Air Force Armaments Group
- Research & Technology Organization
- Industrial Advisory Group
- Need a structure that is better aligned with the Allied Command Transformation to address their future needs.
- Focus
  - Capabilities based structure
  - Joint structure where appropriate.

## **CNAD Implementation Plan**

#### **Capability Management Framework**

JCIG	NAFAG	NAAG	NNAG
Effective Engagement	ACG2 Air Effective Engagement	LCG1 Soldier	MCG1 Above Water Engagement
		LCG2 Combat Manoeuvre	MCG2 Under Sea Engagement
		LCG3 Fire Support	
Information Superiority	ACG1 Advanced Concepts  ACG6 C2 & Distributed Ops		MCG5 Tactical Effective C2
Force Protection & Survivability	ACG3 Air Survivability	LCG4 GBAD JCG CBRN	MCG3 Mine Counter Measures  MCG8 Maritime Electronic Warfare
			MCG7 Maritime Protection
JISR	JCG ISR	LCG6 RSTA	MCG4 ISR  JCG on UAV
Deployability	ACG5 Global Air Mobility	LCG8 Air Mobility & Sp  LCG7 Ground Mobility & Sp	MCG6 Ship Design & Maritime Mobility



#### **Transformation**

#### **Implications on Small Arms**

- All small arms activities are now focused under Land Group 1
- <u>Military transformation</u> will result in identification of actual military needs.
  - More top down guidance
  - Long Term Capability requirements
  - Small Arms needs at the system level
- <u>Civilian transformation</u> to a capabilities based and joint structure
  - Major impacts to some current Land Groups
  - Minor impact to Land Group 1
  - Will become Land Capabilities Group 1 –Soldier
    - Increased responsibilities of training, TTPs etc



#### **Land Group 1 Management**

- Chairman
  - Vernon E. Shisler USA
- Deputy Chairman
  - Koos Meijer NLD
- Rapporteur
  - ➤ Maj Paul McNicholas GBR
- NATO Staff Support
  - ➤ Hugues Briche NATO
- Land Group 1 US Delegation
  - ➤ Ross Guckert PEO Soldier HOD
  - Pat Berger TSM Soldier



#### **Current Land Group 1 Structure**

- Soldier Capabilities & Assessment
  - ► COL Eric Bellot des Minieres FRA
- Combat Clothing Individual Equipment & Protection
  - Henk Reulinmk NLD
- C4I & Systems Architecture
  - Rune Launsund NOR
- Weapons & Sensors
  - Per Arvidsson SWE
  - Mark Richter USA
  - **► US Delegate** Kori Spiegel
- SG/1 Ammunition
  - ➤ COL Dirk Hemerlick BEL
  - US Delegate Sandy Geddes

#### Ad Hoc Team Teams

<u>Power</u>

**Jason Reigner - USA** 

**Head Borne Systems** 

**Dr. Wouter Lotens - NLD** 



#### **Current Land Group 1 Directives**

- Long Term Capability Requirements from the Allied Command Transformation
- MF12/1 Non-Lethal Weapons & Low-Collateral Damage Precision Guided Munitions
- MF12/3 Individual level NATO Network Enabled Capability
- MF12/6 Integrated Personal Protection
- MF12/9 Control of Crowds in Urban Areas

### **Specific Work of Land Group 1**

#### **Network Enabled Capability**

Develop the ability to exchange tactical map information and individual soldier positional information at the soldier

level

#### Demonstrations:

- **▶** Rome Oct 2003
- German Infantry School Oct 2004
- ► French Infantry School Oct 2005





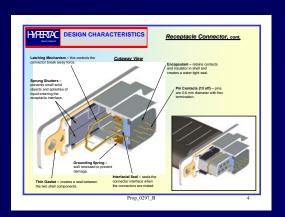


#### **Plugs & Connectors**

- Phased approach
- First Priority the ability to share battlefield power of draw power from national power grid
- Agree on common plugs and connectors
- Establish connections in infantry vehicles and helicopters.









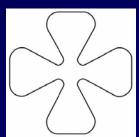
#### **Other Work**

- Ability to share battlefield power at individual level
- Identify and standardize common components and modules
- Combat clothing individual equipment and protection.
- Develop scenarios and rationale for interoperability work



#### **Small Arms Work**

- Certify Ammunition as "NATO Interchangeable"
- Authorize the application of the NATO symbol of interchangeability
- Operate the
  - European Regional Test Center (Pendine GBR)
  - North American Regional Test Center (Lake City AAP USA)
- Maintain Test procedures and standards
- Conduct surveillance tests to assure maintained interchangeability
- Certify national test centers



NATO Symbol of Interchangeability



#### **Small Arms Work**

- Investigating interoperability between the different weapons attachments
- Standardization connecting and power sources





#### **Small Arms Work**

- What are the interface issues with other soldier equipment
- NATO RTO Study under the Systems Concepts & Integration Panel
- Deliver a Technical Report by Dec 2008 addressing issues of:
  - Weapons interfaces
  - Human Factors & analysis
  - Electrical Power
- Firing tests conducted at Quantico May 05, May 06













#### **Small Arms Work**

- Non Lethal Systems
- NATO NL Capabilities Set
- Develop an effects based capabilities list
- Agree Non lethal terms and definitions.
- Addressing impacts of future national programs









- Work with Industry
- NATO Industrial Advisory Group (NIAG)
- Study Title: Integration of C4I on Soldier Systems
- ▶ Budget Estimate: €300,000
- Duration April 06-March 07
- First meeting 30 March 06

Purpose: A pre-feasibility study for an autonomous, covert system to: draw information form a central Common Operating Picture for dismounted systems....facilitate automatic transfer of intelligence, target information etc



- Work with Industry
- NATO Industrial Advisory Group (NIAG)
- Study Title: Interoperability for the soldier Systems
- Budget Estimate: €150,000
- Duration April 06-April 07
- First meeting 31 March 06

Purpose: To study the issues and potential standards associated with interoperability of various soldier system components. ..identify potential standards...technical benefits and shortcomings ...



#### Summary

- NATO is undergoing a rapid transformation
- Land Group 1 will become Land Capability Group1 next year.
- All small arms and dismounted operations are in one place
- Allied Command Transformation is engine for change.



## NDIA International Small Arms Symposium, Exhibition & Firing Demo 2006



## The First Three Hundred Years Of Small Arms

(1326 - 1626)



By Stephen C. Small, Ph.D.



## Agenda



- Background
- East or West?
- Users
- Firearms
- Adaptation
- Battle
- Learning
- Clockwork
- C. 1626
- Historical Lessons?
- Q & A





# Background











## Medieval Europe





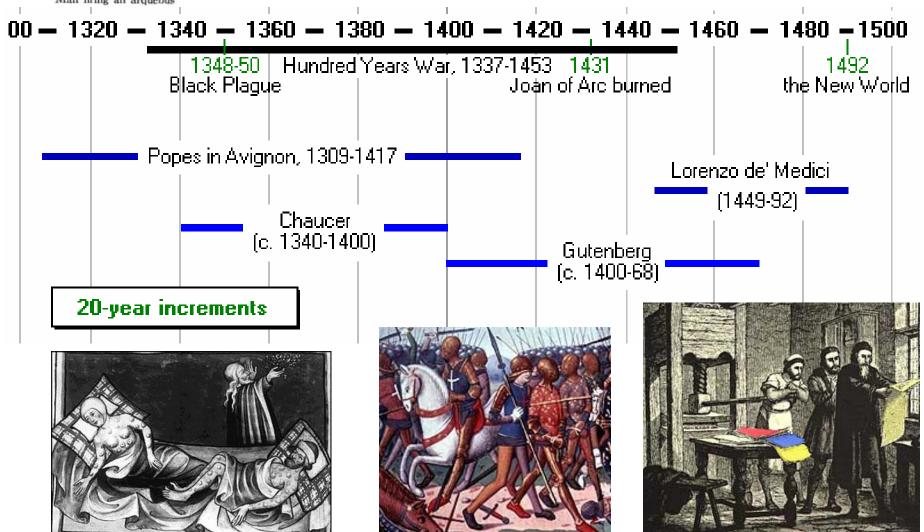






## Chronology

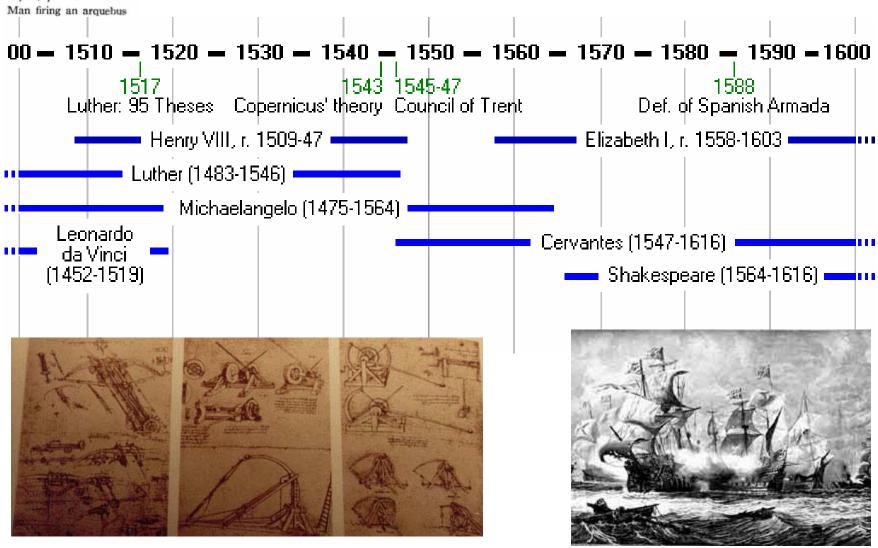






## Chronology







# East or West?









### Devil's Powder







# Inventor of the Firearm?





"Devised by the devil himself, a pipe of iron, loaded with powder"





# <u>Users</u>







#### User Status at Risk





"To be soaked in one's own sweat and blood, that I call the true bath of honor"

- Henry of Laon

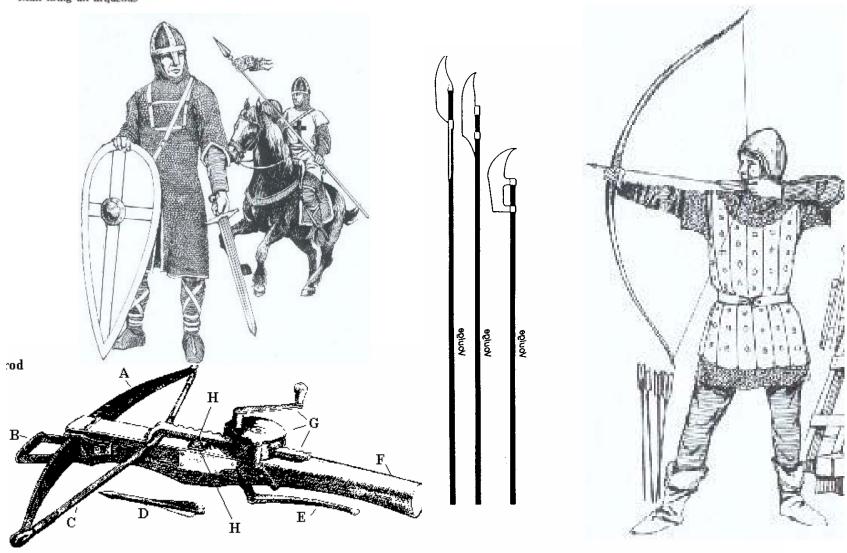






#### The Hand-Held Weapons

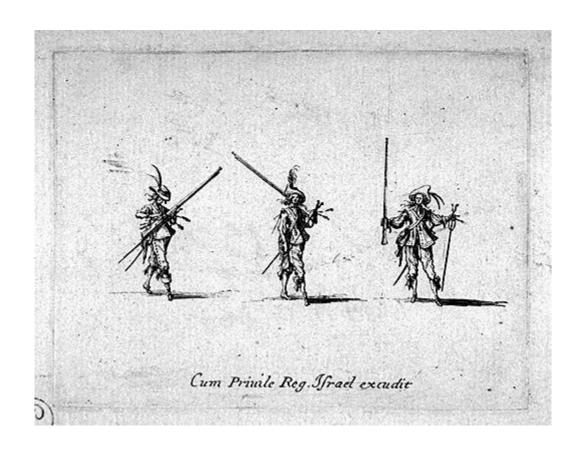






# **Firearms**

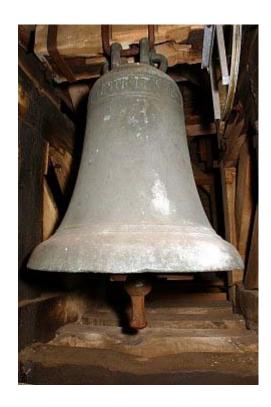






# Medieval Bell Makers











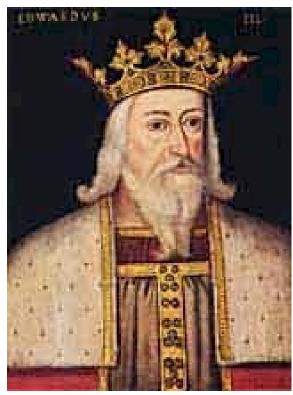


### The First Firearm?



c. 1326







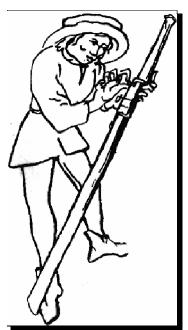
# The First Small Arm System? C. 1350





Hand cannon of ca.1350, found near Loshult, Sweden. National Historical Museum, Stockholm.

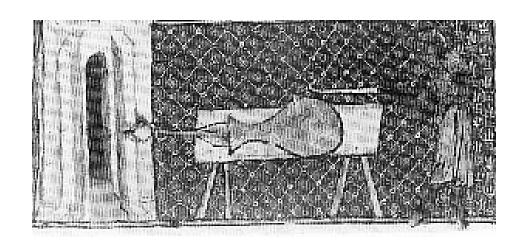






#### **Ammunition**





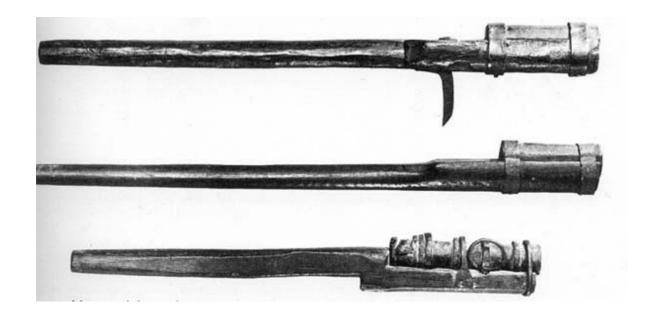


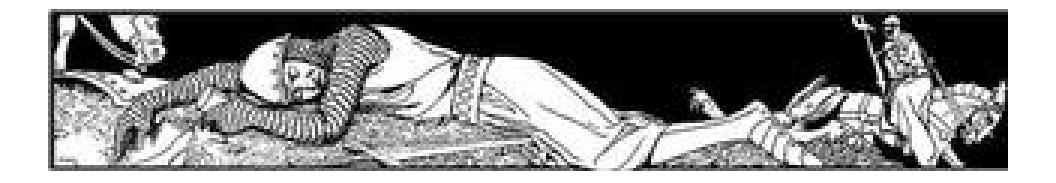
"...a thunderer which shot balls the size of apples"



## Small Arms Ascendancy









### Religion and Weaponry













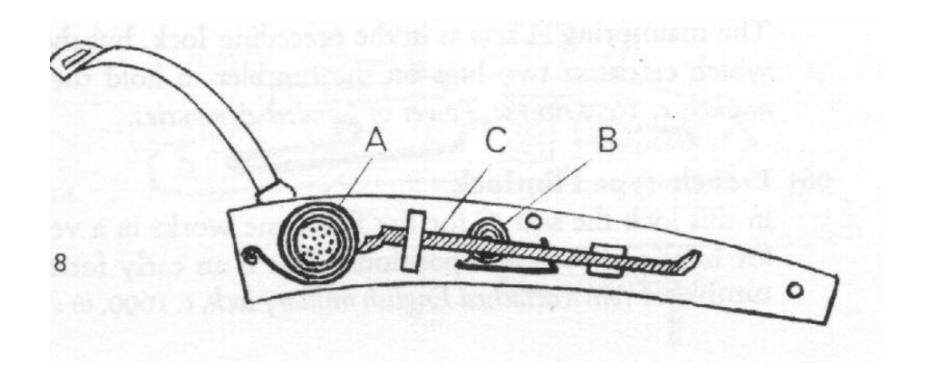








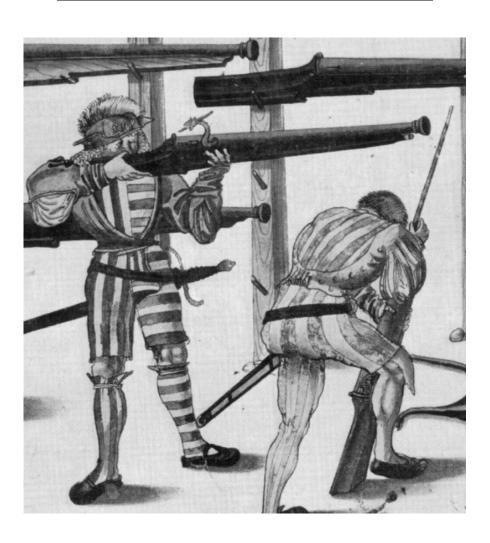
## Snapping Matchlock





# **Adaptation**

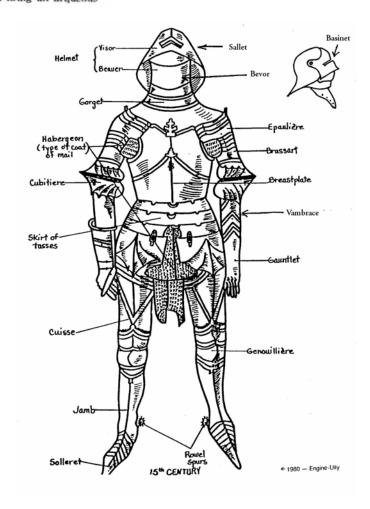






# The Armored User c. 1450



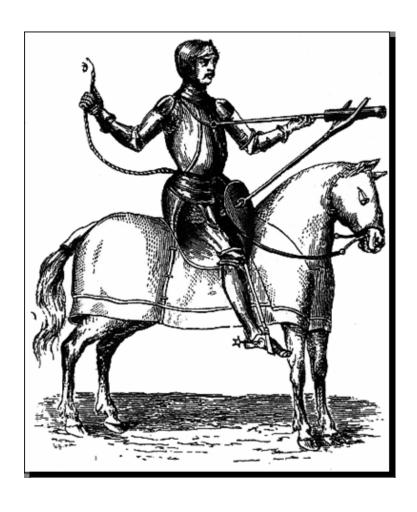


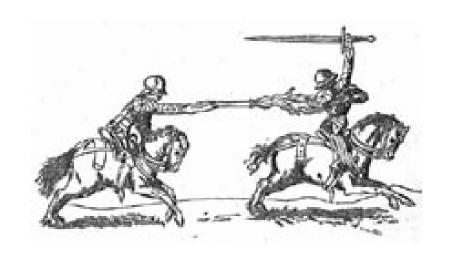




### Melding Old and New









## Hybrid Small Arms





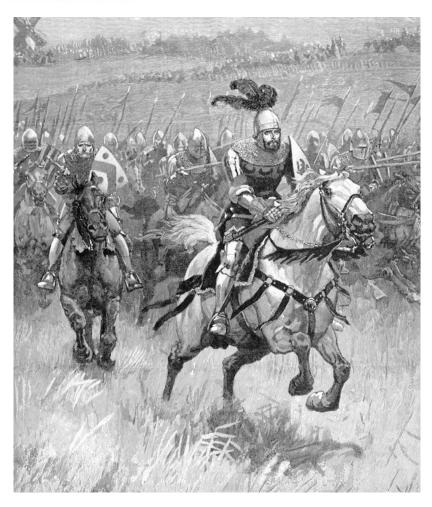




### Small Arms in Battle



Man firing an arquebus









# Battle of Barnet April 1471







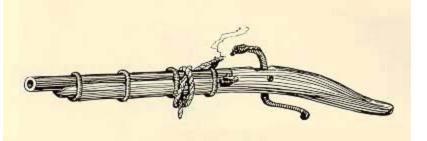


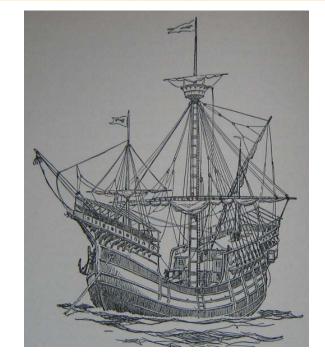


# Alfonso de Albuquerque c. 1511











### Battle of Pavia February 1525





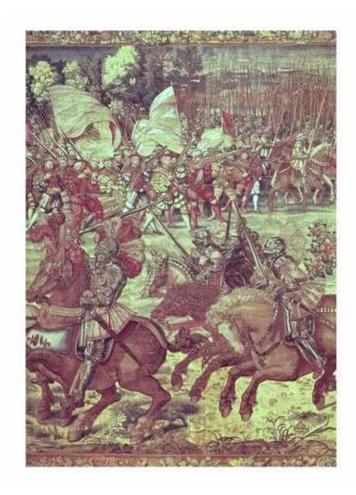






# Battle of Pavia Francis I and his Knights



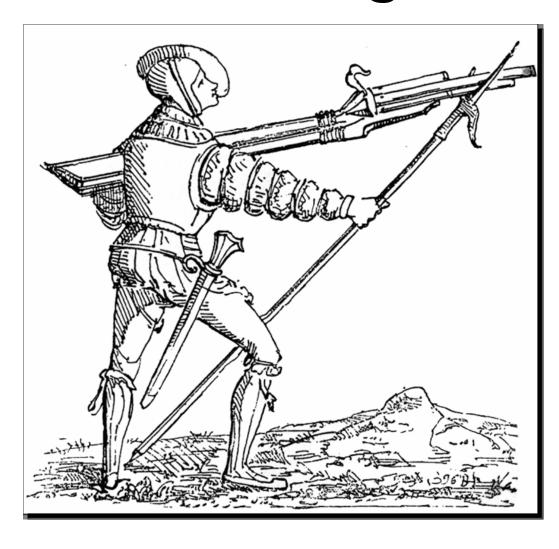






# Guesswork and Learning

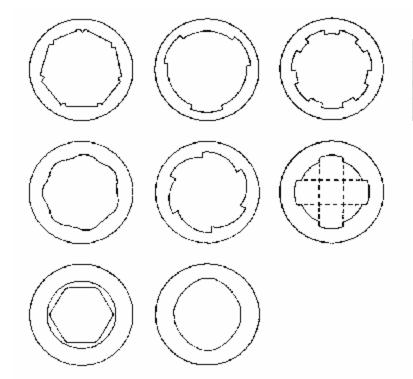


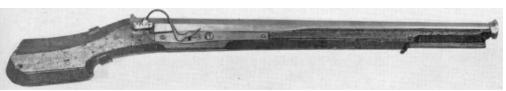




# **Rifling** c. 1550











# Weapons Analysis c.1599





### PARADOXES OF DEFENCE.

WHEREIN IS PROVED THE TRVE grounds of Fight to be in the fhort aument weapons, and that the fhort Sword hath advantage of the long Sword or long Rapier. And the weakeneffe and imperfection of the Rapier-fights displayed, Together with an Admonition to the noble, ancient, victorious, valiant, and most braue nation of Englishmen, to beware of false teachers of Defence, and how they for lake their owne natural fights; with a briefe commendation of the noble science or exercising of

Armes,

By George Silver Gentleman,



LONDON,
Printed for Edvvard Bloum.
1 599.



# Small Arms Training



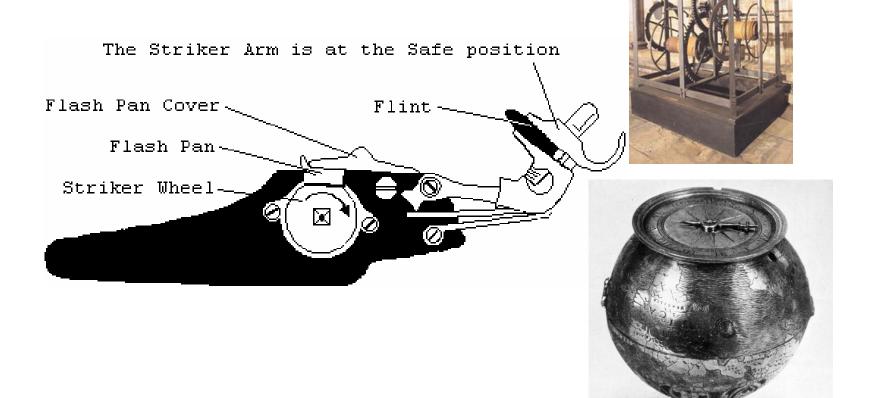






## **Clockwork Firearm**

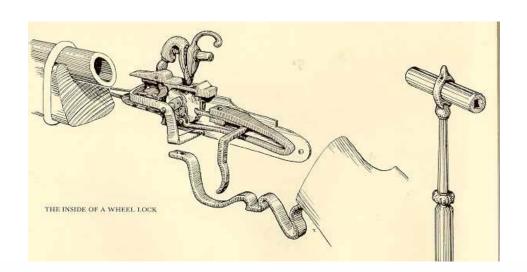






#### The Wheel-Lock









#### German Wheel-lock Anti-Materiel Rifle



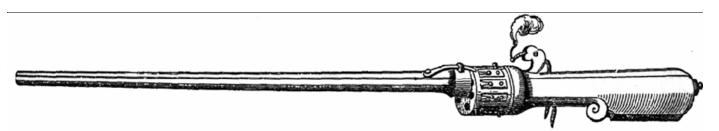


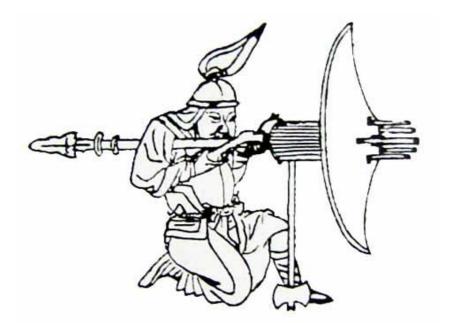
Weight: 41. 8 pounds Length: 7 feet 6 inches Caliber: 27mm



# Repeating Firearms





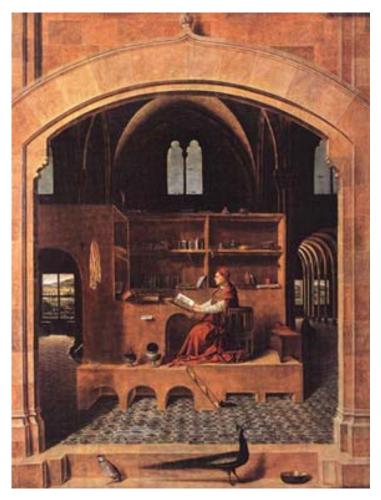


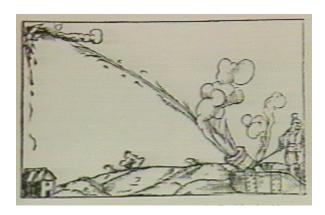


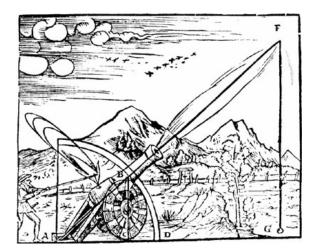


# **Professionalism**





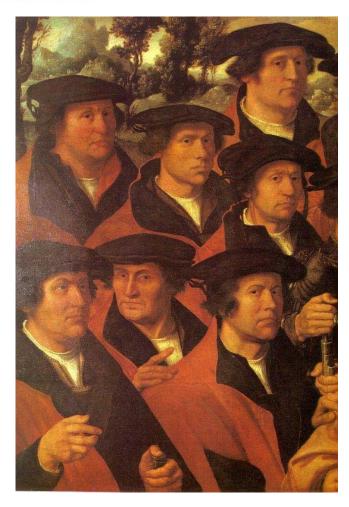






# Arms-makers Guilds





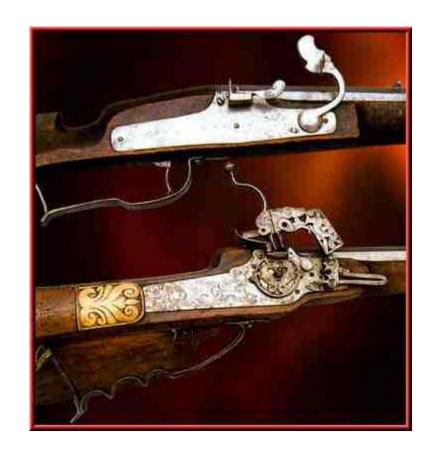






# c. 1626







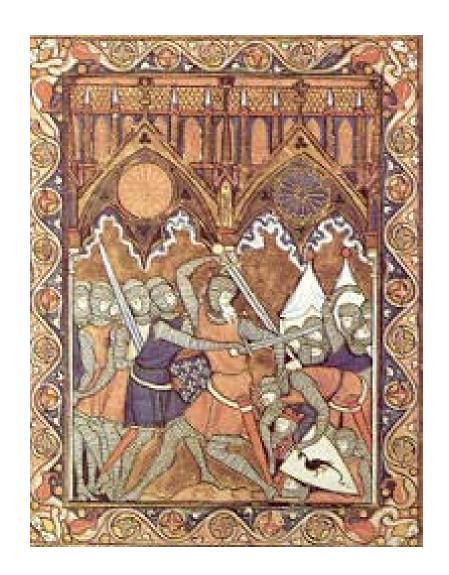


# Historical Lessons?



- Users sometimes got it wrong
- ➤ Old technologies give rise to the new
- Legacy systems linger on







# **Questions?**









Stephen C.
Small, Ph.D.
(973) 724-7043
ssmall@pica.army.mil









# S.C.A.R.

### S.O.F. COMBAT ASSAULT RIFLE





**OPERATOR ENVISIONED, TESTED, CHOSEN** 



18 May 2006





#### **SCAR**



#### Operator Envisioned, Tested, and Chosen



# SCAR Gives The SOF Operator A Weapon That Is Specifically Designed For SOF By SOF





## Briefing Outline



- Why SCAR?
- What is SCAR?
- SCAR Way Ahead
- Review of Test Data
- Program Summary









## Why SCAR?



SCAR Program Fills a Need That Years Of SOF Operator Experience Tells Us Still Exists



A Multipurpose Weapon of Choice With Choices for Today's And Tomorrow's Battlefields



SCAR Program Will Field The Best Possible Weapon System To The SOF Operator



**USSOCOM** *Is* Leading The Next Evolutionary Step In Small Arms Development...At A Revolutionary Pace





## SCAR Weapons Replacement













MK18

M4A1

MK12

MK11

M14/EBR









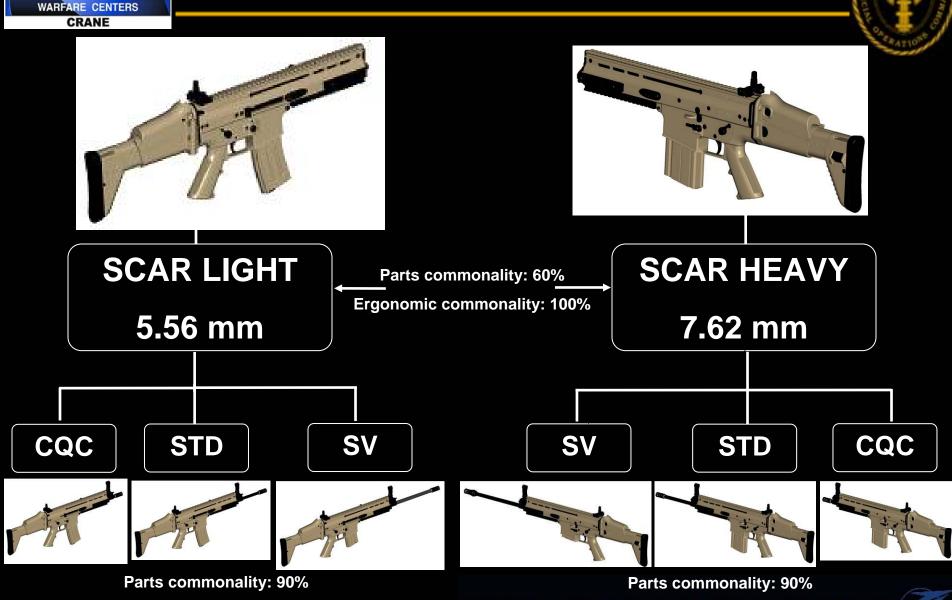
SCAR LIGHT 5.56 mm

SCAR HEAVY 7.62 mm





#### What Is SCAR?





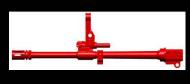
## SCAR Future Capabilities





0.87" In Length & 0.1 lbs From A Common Upper Receiver

Choose Caliber & 
Barrel Type





Match Trigger ← Module to Caliber





**Match Bolt To** 



#### EGLM & FCU



- EGLM Provided With 40mm Weapon Module, Fire Control Unit Increment I (Mechanical With Integrated Laser/MRD Sight) And Stand Alone Stock
  - Weapon: Left Or Right Hand Operation, Locked Breach, Provides Capability
  - To Fire All 40mm Rounds And Future Medium Velocity Ammunition
  - FCU Increment I: Mechanical With Integrated Laser/MRD Sight
  - → FCU Increment II: Laser Range Finding/Pointer To 600 Meters With Ballistic Solution, Quick On/Off With No Effect On Host Weapon Zero



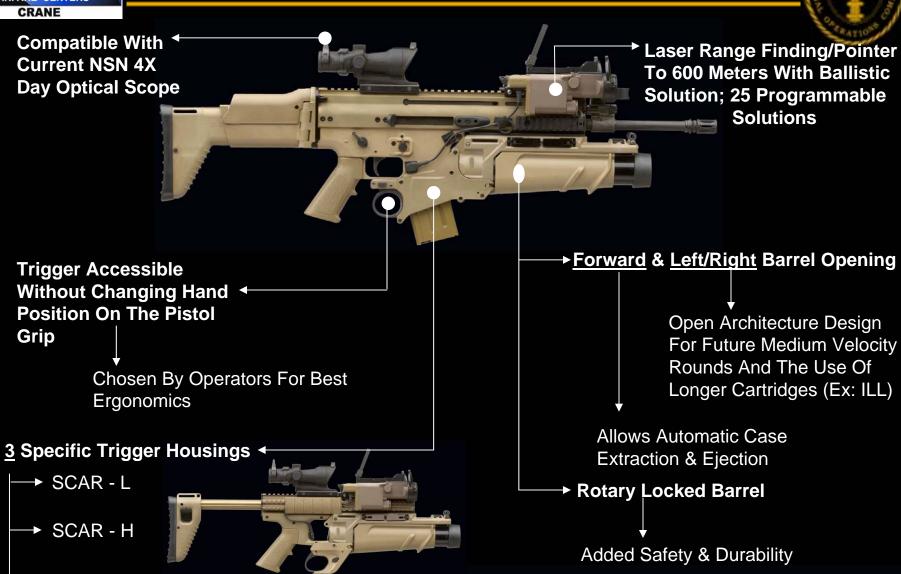








#### **EGLM & Fire Control Unit**



→ Stand Alone



## Program Highlights









SCAR - Heavy (7.62mm)

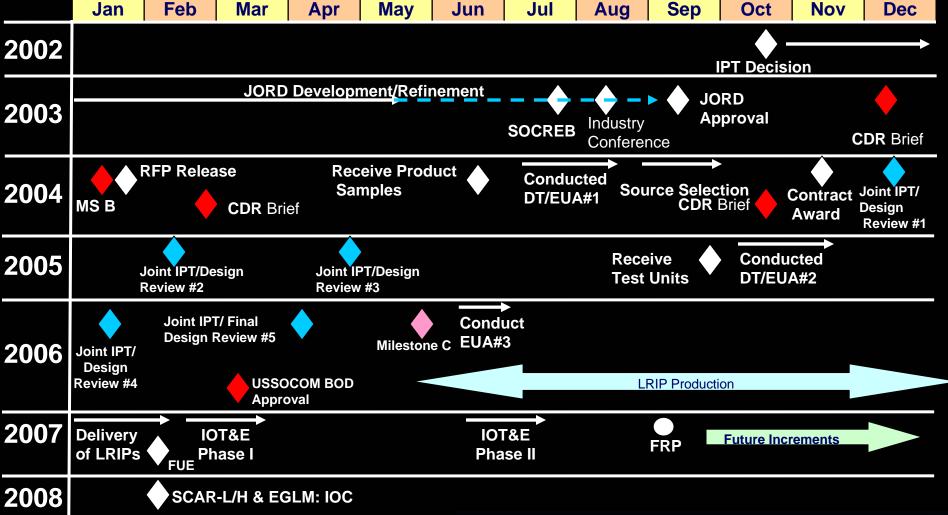
- Conducted In A Full And Open Competition
- Continuous Operator Involvement
- Less Than 10 Months From Solicitation Issue To Contract Award
- Contract Awarded 5 November 2004 To FN Herstal
- Accelerated Development Of SCAR-H And EGLM to Coincide with SCAR-L
- Completed Phase 2 Testing in November 05 with 16 Operators
- Milestone C Authorization Pending To Support LRIPs
- USSOCOM Investment of Approximately 3.0M To Date
- True Teaming Triad Between Operators, Government And FN





#### Program Development/Way Ahead









### SCAR/EGLM



# **Developmental Test Overview**





## SCAR-L Technical Data









SCAR-L 5.56mm CQC with EGLM mounted



SCAR-L 5.56mm CQC

FEATURES	CQC	STD	SV
Operating Principle	Gas Operated S	hort Stroke Pist	on, Rotating Bolt
Firing Modes	Single Shot, Full Auto		
Feed System	30 rds, M16 Magazine Type		
Rate of Fire	550-600 Rounds Per Minute		
Accuracy	0.5 to 0.7 MOA>Ammo @300m		<b>@300m</b>
Weight Without Magazine With Iron Sights	6.73 lb	6.97 lb	7.56 lb
Maximum Overall Length	29.78 in	33.56 in	38.00 in
Minimum Overall Length	28.25 in	32.10 in	36.38 in
Maximum Overall Length, Stock Folded	20.88 in	24.63 in	29.00 in
Barrel Length	9.96 in	13.82 in	18.00 in





## **SCAR-H Technical Data**







SCAR-H 7.62mm STD

SCAR-H 7.62mm CQC

FEATURES	CQC	STD	SV
Operating Principle	Gas Operated Short Stroke Piston, Rotating Bolt		on, Rotating Bolt
Firing Modes	Single Shot, Full Auto		
Feed System	20 rds, FAL Box Magazine Type		
Rate of Fire	550-600 Rounds Per Minute		
Accuracy	0.5 to 0.7MOA > Ammo at 300 meters		
Weight Without Magazine With Iron Sights	6.80 lb	7.16 lb	7.64 lb
Maximum Overall Length	30.50 in	36.39 in	41.24 in
Minimum Overall Length	29.00 in	34.88 in	39.74 in
Maximum Overall Length, Stock Folded	21.63 in	27.50 in	31.74 in
Barrel Length	9.96 in	15.75 in	18 to 20 in





## SCAR DT KPP Data Summary



KPP's	THRESHOLD AND OBJECTIVE	EX16 SCAR L (S)	EX17 SCAR H (S)
Adapt - Barrel Change	Barrel Change By Operator W/O Headspace Adjustments Within 20min ( <b>T</b> ), Within 5min ( <b>O</b> )	MEETS (T) REQT	MEETS (T) REQT
Reliability	SCAR L/H Using M855&M80 Ball, Shall Have A Mean Round Between Stoppage (MRBS) Of 2,000rds ( <b>T</b> ), 8,000rds ( <b>O</b> )	MEETS (T) REQT	MEETS (T) REQT
Con't	Shall Have A Mean Round Between Failure (MRBF) Of 15,000rds ( <b>T</b> ), 35,000rds ( <b>O</b> )	MEETS (T) REQT	MEETS (T) REQT
Con't	Functional System Service Life, W/O Overhaul of 15,000rds ( <b>T</b> ), 90,000rds ( <b>O</b> )/Barrel Life of 15,000rds ( <b>T</b> ), 35,000rds ( <b>O</b> )	MEETS (T) REQT	MEETS (T) REQT
Acceptance Accuracy	Baseline Ammunition Extreme Spread Plus 1 MOA @ 300yds ( <b>T</b> ), 0.25MOA @ 300yds ( <b>O</b> )	MEETS (T) REQT	MEETS (T) REQT





## SCAR DT APP Data Summary



APP's	THRESHOLD AND OBJECTIVE	EX16 5.56mm	EX17 7.62mm
Firing Rate	The SCAR shall have a rate of fire optimizing the reliable function of the weapon system with and without sound suppression (T).	MEETS (T) REQT	MEETS (T) REQT
Drain Time	SCAR L/H shall require no more than 2 sec drain time after Full submersion in, and removal from sea water after firing Mode selection ( <b>T</b> ), Zero drain time ( <b>O</b> )	MEETS (T) REQT Standard MEETS (O) REQT cqc	MEETS (T) REQT
Size	SCAR-L shall be collapsible or foldable to lengths not greater than 29.9" folded/collapsed and 33.6" extended with standard barrel (T). SCAR H collapsible or foldable to lengths 30.3" folded/collapsible and 40.2" extended with standard barrel (T).	MEETS (T) REQT	MEETS (T) REQT
Weight	The SCAR-L without magazine, shall weigh no more than 7.25lbs unloaded ( <b>T</b> ), less than 6.6lbs unloaded ( <b>O</b> ) The SCAR-H shall weigh no more than 9 lbs (T), less than 8 lbs (O).	MEETS (T) REQT	MEETS (O) REQT
Jump Bag	SCAR L/H Shall Utilize the Current In-Service Jump Bag (T)	MEETS (T) REQT	MEETS (T) REQT





## **EGLM Technical Data**









SCAR-L w/EGLM & FCU

**EGLM On Stand Alone Stock** 

**EGLM w/Trigger Assembly** 

FEATURES	EGLM
Mechanism	Slide Action, Rotary Locking- DA Trigger
Weight (w/o Sight Assembly)	3.02 lb / Launcher
Length (w/ Trigger Assembly)	16 in / 9in Barrel
Fire Control Unit (Increment II)	Laser Ranging/Pointer (600m), 40mm Ballistic Solution
	40mm Bamsuc Solution
Modularity	Mounts To SCAR-L/H,
	And Stand Alone Stock
Stand Alone Stock	20.25 – 26.63 in Long / 2.74lb





## EGLM DT KPP Data Summary



KPP's	THRESHOLD	EX13 EGLM
1.	Single Shot, 40mm Low Velocity (40x46mm)	MEETS REQUIREMENT
2.	Attaches To SCAR L/H & Stand Alone Stock Via Mil Std 1913 rail.	MEETS REQUIREMENT
3.	Fire Control Unit (Increment II) w/Day – Night Targeting and Ranging Capabilities	Meets Concept – Operational Issues w/ Size, Weight, Ease of Use and Overall Performance
4.	Interoperable w/U.S. 40mm Ammo And SOPMOD Equipment	MEETS REQUIREMENT
5.	Safe During Transport, Storage, And Use	MEETS REQUIREMENT
6.	Design Shall Not Limit Length Of 40mm Round	MEETS REQUIREMENT
7.	Design Shall Have A Mechanical Safety	MEETS REQUIREMENT





## EGLM DT APP Data Summary



APP's	Requirement	EX13 EGLM
Size/Weight	Detached, Shall not Exceed 16in ( <b>T</b> ) Stock Assembly 3.5lb ( <b>T</b> ) 1.0lb ( <b>O</b> ) Weapon &Fire Control 6.5lb ( <b>T</b> ) 2.0 ( <b>O</b> ) Stand Alone Weight 10.0lb ( <b>T</b> ) 4.0lb ( <b>O</b> )	MEETS (T) REQUIREMENT
Trigger	Incorporate Double Action Trigger (T)	MEETS (T) REQUIREMENT
Fire Control Unit (Increment II)	Manual Input of Range ( <b>T</b> ) Range from 40 to 600m, Day/Night ( <b>T</b> ) Range Target every 2 Seconds ( <b>O</b> ) Vertical Elevation Compensation ( <b>O</b> )	MEETS (T) REQUIREMENT MEETS (T) REQUIREMENT MEETS (O) REQUIREMENT MEETS (O) REQUIREMENT
Accuracy	8/10 Hits to 200m ( <b>T</b> ), 6/10 Hits from 200- 300m( <b>T</b> ) 8/10 Hits Point Target 36 by 36in @100M ( <b>T</b> )	MEETS (T) REQUIREMENT
Reliability (Launcher)	MRBF Class 1 – 1,200rds 3 – 3,000rds 2 – 1,500rds	MEETS (T) REQUIREMENT
Service Life	5000 rd Effective Barrel Life ( <b>T</b> ) 5000 rd System Service Life ( <b>T</b> )	MEETS (T) REQUIREMENT





#### Summary



- Full & Open Competition
- Designed For SOF By SOF
- Less Than 10 Months From Solicitation Issue To Contract Award
- 45 Months From Solicitation Issue to Full Rate Production
- 5 Joint IPTs/Design Reviews With SOF Operators, Combat Developers, Government And FN Personnel
- Modular Concept Supports Future Growth
- USSOCOM Investment Of Approximately 3.0M To Date





#### **Contact Information**



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NSWC Crane



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MAJ Eric Glenn
Systems Acquisition Manager - Weapons
USSOCOM (PEO- SOF Warrior)
Commercial: 813-828-9422

Email: glenne@socom.mil







#### **Lightweight Small Arms Technologies**



Lightweight Small Arms Technologies (LSAT)



# National Defense Industrial Association Joint Services Small Arms Systems Annual Symposium May 2006

Ms. Kori Spiegel US Army ARDEC (973) 724-7912 kori.spiegel@us.army.mil

Mr. Paul Shipley AAI Corporation (410) 628-3462 shipley@aaicorp.com













# Lightweight Small Arms Technologies Top 5 Soldier Weight Contributors



Lightweight Small Arms Technologies (LSAT)

#### For Automatic Rifleman:



- 2. 5.56mm Ammunition (400 rounds)
- 3. Body Armor & Helmet
- 4. Communication Equipment
- 5. Canteen/Water

















# Lightweight Small Arms Technologies Goals



Lightweight Small Arms Technologies (LSAT)

#### <u>Goals:</u>

- 35% weapon weight reduction
- 40% ammunition weight reduction
- Reduced training & maintenance
- Maintain cost of current systems





#### Approach:

- "Clean Slate" design
- Reduced weight as the priority
- In depth trade studies
- Extensive modeling & simulation









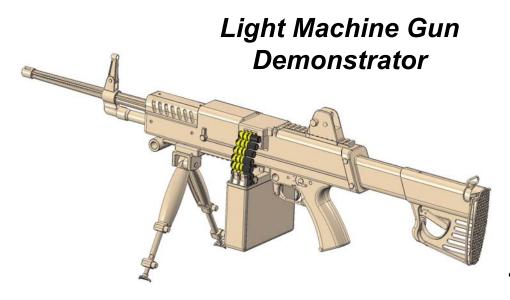




# Lightweight Small Arms Technologies Program Approach



Lightweight Small Arms Technologies (LSAT)



- Achieve 50% overall weight reduction
- Pursue parallel Cased Telescoped and Caseless Ammunition design approaches
- High commonality of design and function, some action component differences

#### 5.56mm Telescoped Ammunition



- Focus is development of technologiesnot specific weapon system
- Demo via Light Machine Gun with 5.56mm ammunition
- In parallel, Company Machine Gun study to determine feasibility of single weapon with a single round of ammunition for both LMG and MMG









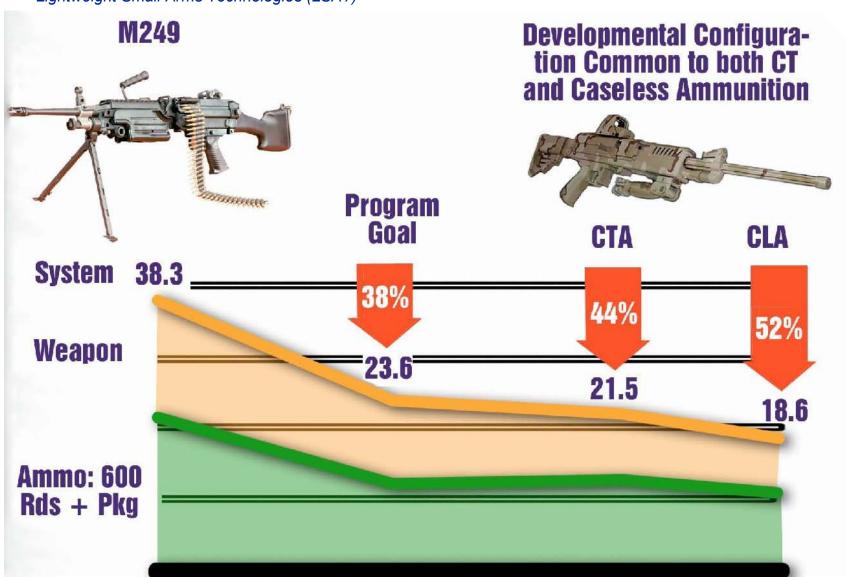




# Lightweight Small Arms Technologies Comparative Weights



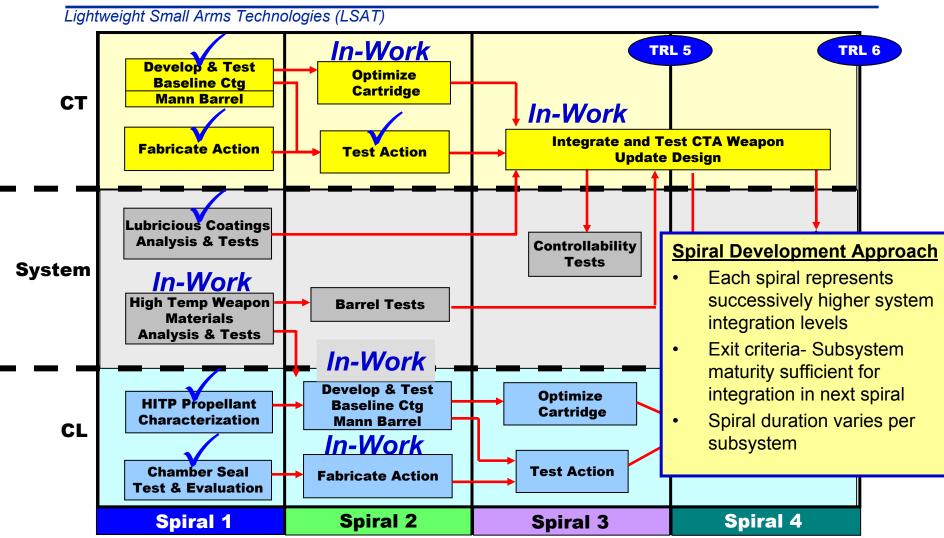






# Lightweight Small Arms Technologies Concurrent & Leveraging Activities













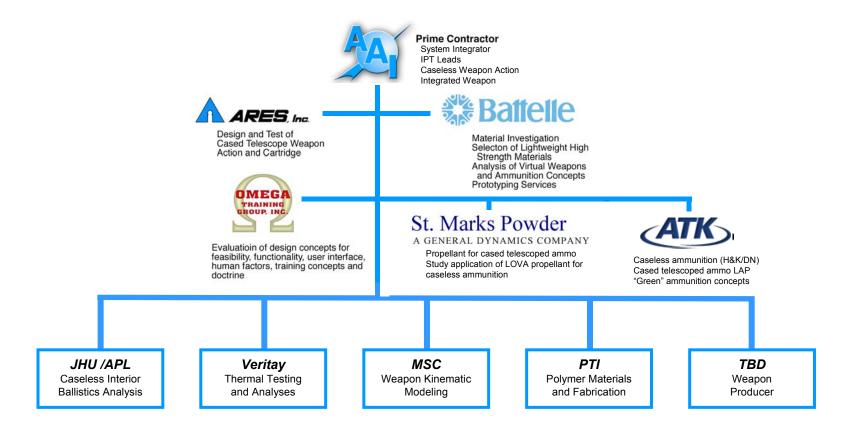




# Lightweight Small Arms Technologies AAI Contractor Team Members



Lightweight Small Arms Technologies (LSAT)









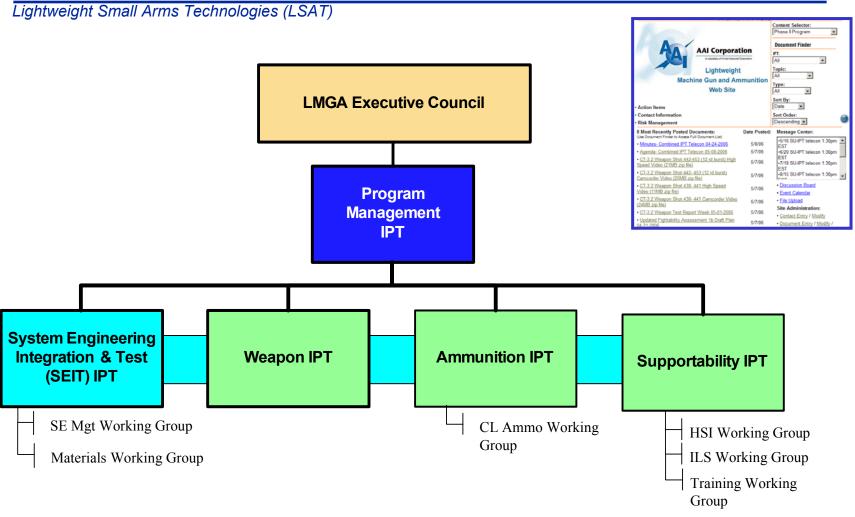






# Lightweight Small Arms Technologies Integrated Product Team Organization

















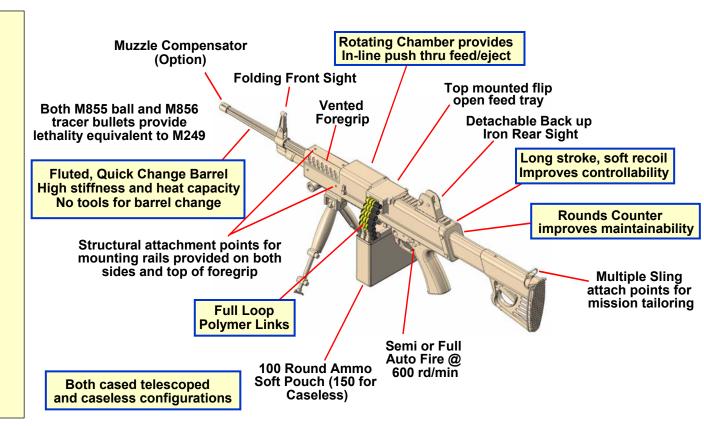
# Lightweight Small Arms Technologies Weapon Design and Performance Features



Lightweight Small Arms Technologies (LSAT)

#### Key technologies

- Use of telescoped ammocased and caseless
- Lightweight materials & structural configuration
- Thermal management for weight reduction
  - Barrel
  - Caseless chamber components
- Caseless chamber sealing
- Human factors- firing controllability
- Integration of electronics











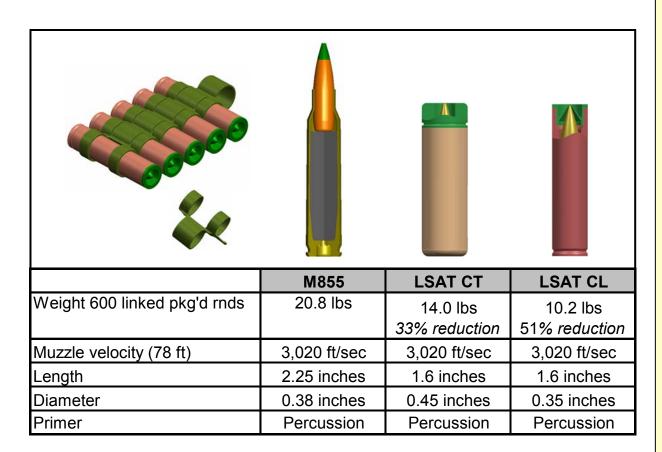




### Lightweight Small Arms Technologies Ammunition Design Features



Lightweight Small Arms Technologies (LSAT)



#### Key Technologies

- Telescoped cartridge
- Cased Ammunition
  - Polymer cartridge case and endcap
  - Compacted propellant (tracer rd)
- Caseless Ammunition
  - High Ignition
     Temperature Propellant
  - Booster assisted interior ballistics
- Demonstrate in 5.56mm
  - Address producibility
  - Consider scalability















Lightweight Small Arms Technologies (LSAT)

### Cased and Caseless Telescoped Ammunition

Design and Development Status







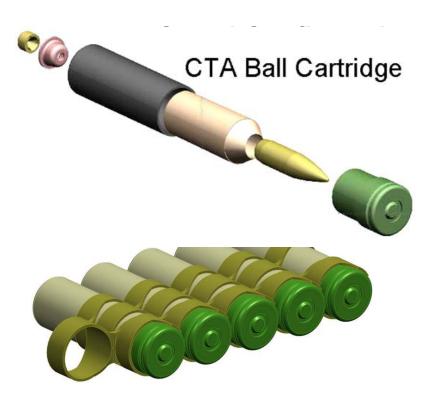




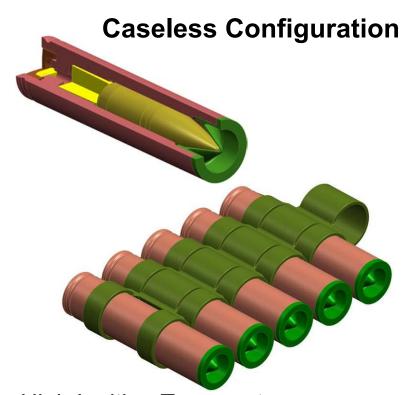


### Lightweight Small Arms Technologies Ammunition Features





- Conventional technology in telescoped configuration
- Significant weight reduction
- Lower Risk



- High Ignition Temperature Propellant Technology
- Higher Weight Reduction
- Higher Risk













# Lightweight Small Arms Technologies Cased Telescoped Ammunition Status (1)



- Technology demonstration with std 5.56mm bullet
- Completed Activities
  - Development of "Weapon Function Cartridge"
  - All telescoped ammunition features, but not optimized for weight/size
  - Used to support initial weapon testing (SN CT1)
- Activities nearing completion
  - Development of "Optimized Cartridge"
  - Reduces cartridge weight/size
- Approximately 750 rds fired to date
  - Both Mann Barrel and Weapon
  - Temperatures ranging from -65F to +145F













### Lightweight Small Arms Technologies Cased Telescoped Ammunition Status (2)



- Interior ballistics results
  - Achieved performance equivalent to M855 baseline (ie, Propellant Wt, Pch, Vm)
  - Primer initiation parameters differ significantly from metallic case
- Case/End Cap material and geometry results
  - Approximately 15 materials tested using injection molded cases.
  - Numerous geometry variations tested- primer interface, bullet interface, cartridge sealing, case thickness profile
  - Baseline selected, currently preparing final test series





Cracked Case



**Successful Case** 













# Lightweight Small Arms Technologies Caseless Ammunition Status (1)



- Significant level of cooperative test and analysis activities between ARDEC and contractor team
- Objectives
  - Characterize chemical and physical characteristics of High Ignition Temperature Propellant (HITP)
  - Replicate HITP to match ballistic and mechanical properties of ACR ammunition
  - Demonstrate HITP production feasibility
    - Process simplification
    - Process control
    - Process scalability
  - Deliver prototype 5.56mm caseless ammunition for ballistic demonstration













# Lightweight Small Arms Technologies Caseless Ammunition Status (2)



- HITP Materials & Process Development
  - ✓ Characterize safety & physical properties of raw materials
  - ✓ Identify material sources and/or synthesize
  - ✓ Develop propellant mixing & fabrication process
  - ✓ Characterize and replicate HITP thermal & ballistic characteristics
- Integrated Cartridge Demonstration
  - ✓ Design & build proof-of-concept tooling for fabrication studies
    - Fabricate both 4.92mm (ACR) and 5.56mm cases
    - Fabricate primer cups
  - Fire 4.92mm cartridges in Mann Barrel for comparison with ACR ammo
    - Match ballistic performance through process & formulation improvements
  - Use 4.92mm cartridge fabrication process as baseline for 5.56mm cartridge production









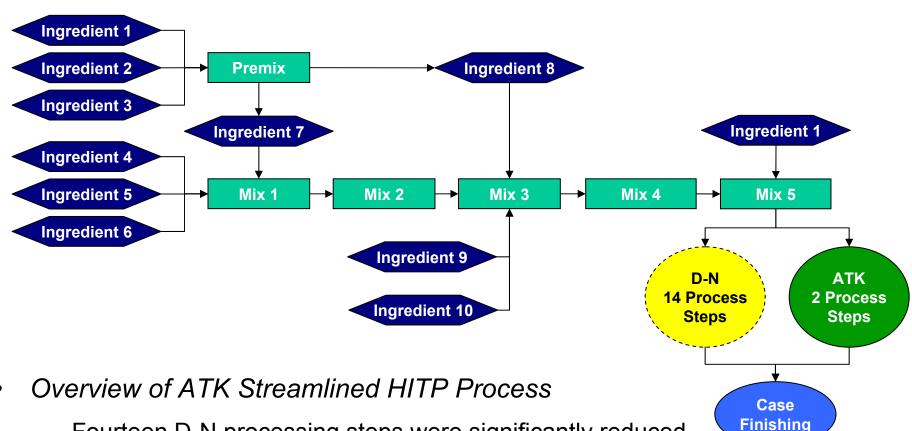




### Lightweight Small Arms Technologies Caseless Ammunition Fabrication Process



Lightweight Small Arms Technologies (LSAT)



 Fourteen D-N processing steps were significantly reduced, resulting in significant reduction in cycle time and production costs













### Lightweight Small Arms Technologies Completed 4.92mm HITP Cartridge Bodies



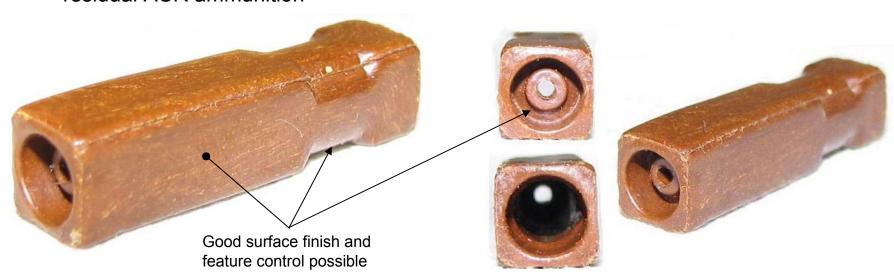
Lightweight Small Arms Technologies (LSAT)

- Fabricated using improved process
- Duplicates ACR configuration
  - Demonstrated good dimensional match to ACR ammunition with improved process approach



Assembled ACR

Preparing to conduct ballistic comparison testing vs. residual ACR ammunition















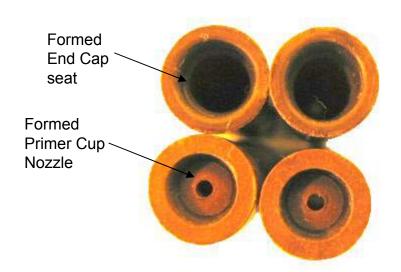
# Lightweight Small Arms Technologies Completed 5.56mm HITP Cartridge Bodies



- Fabricated using improved process, cylindrical
   5.56mm cartridge configuration
  - Demonstrated good dimensional control
  - Preparing to conduct ballistic testing once 4.92mm cartridge demonstration testing complete

















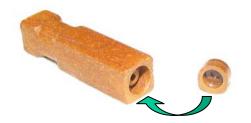


# Lightweight Small Arms Technologies Completed HITP Primer Cups



Lightweight Small Arms Technologies (LSAT)

- Specialized HITP formulation developed for Primer Cup
  - Cups are loaded with off-the-shelf primer composition and inserted into caseless cartridge bodies
  - Cups are sized to universally fit into 4.92mm or 5.56mm case configurations
- Demonstrated good dimensional control and good mechanical properties with processing that is amenable to high-rate production
- Preparing to conduct primer charging tests









Primer Cup for both 4.92mm and 5.56mm case configurations









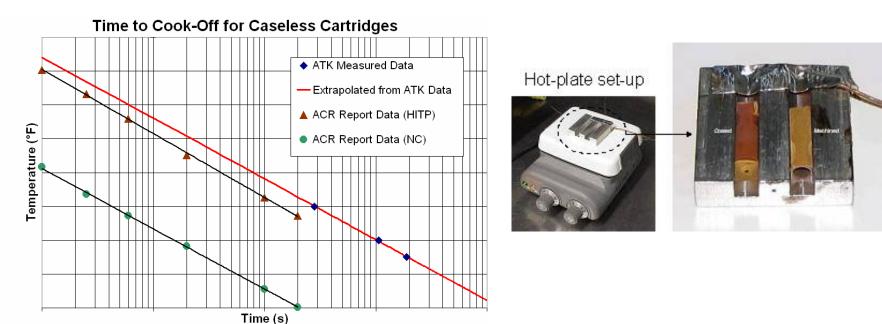




### Lightweight Small Arms Technologies HITP Thermal Characterization



- Thermal stability and characteristics of HITP were studied through surface heat "hot-plate" cook-off testing
  - Results compared well with published data
  - Threshold cook-off temperature was determined to be significantly higher than conventional NC ball powder











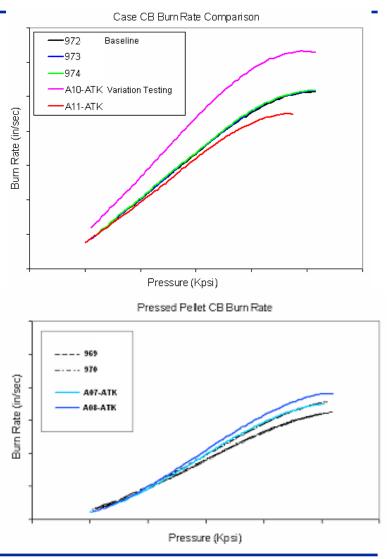




### Lightweight Small Arms Technologies HITP Burn Rate Studies



- High pressure closed bomb testing performed on HITP pellets & cartridges
- Effects of variation on burn rate being studied
  - Process changes
  - Formulation changes
- Optimal formulation testing continues















# Lightweight Small Arms Technologies Caseless Ammunition Summary



- Caseless ammunition provides 50% weight reduction vs. standard ammunition
- Accomplishments
  - Demonstrated ability to replicate ACR HITP
  - Demonstrated manufacture of dimensionally accurate propellant bodies and primer cups using a process scaleable to production
- Upcoming Milestones
  - Cartridge integration- 4.92mm & 5.56mm
  - Validation of integration of ATK 4.92mm cartridge performance vs. ACR cartridges using Mann Barrel
  - Firing of confidence cartridges to demonstrate scale-up to 5.56mm



















Lightweight Small Arms Technologies (LSAT)

### Cased and Caseless Weapon

Design and Development Status













# Lightweight Small Arms Technologies CT Weapon Kinematic Model (2)



- Weapon Kinematic Modeling Approach
  - MSC ADAMS software
  - Model developed by MSC
  - All geometry derived from weapon and ammunition 3D solid models
  - All functional parts modeled- correct size, weight, stiffness, contacts
- Purpose of Model
  - Verify geometric clearances and component ranges of motion
  - Provide full kinematic characterization of weapon and ammo
  - Develop component loads for FEA analysis
  - Identify potential issues/solutions during design process
  - Validate based on test data, then support diagnosis/correction of problems identified during firings
  - Support integrated weapon analyses- drop, vibration etc













# Lightweight Small Arms Technologies CT Weapon Kinematic Model (3)



- Representative initial design issues identified via ADAMS model
  - Feed pawl over-ride: corrected via revised pawl geometry
  - Rammer bounce: added lock to design
  - Chamber bounce: revised initial lock design
  - Inconsistent ejection: elected to monitor during tests
  - Significant belt whip: elected to monitor during tests
- Representative design studies conducted using ADAMS model
  - Sensitivity to friction
  - Effect of gas pulse profile
  - Link stiffness effects- stresses and belt pull
  - Belt support options
  - Integration with MSC NASTRAN and LS DYNA to evaluate stresses, deformations, and contact loads
- Modeling enabled significant reduction in weapon development time







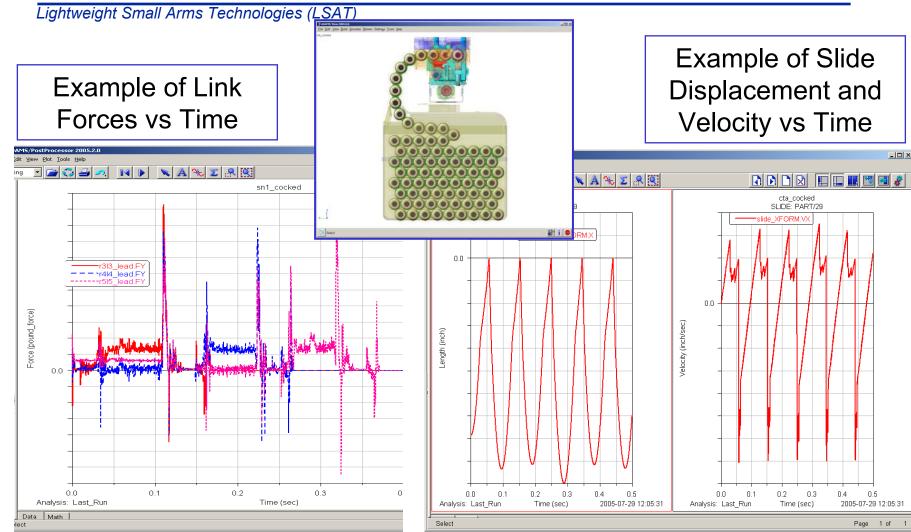






# Lightweight Small Arms Technologies CT Weapon Kinematic Model (4)

















# Lightweight Small Arms Technologies Cased Telescoped Weapon Status



Lightweight Small Arms Technologies (LSAT)

#### Serial Number CT1

- Basic functionality demonstrated
  - Weapon Action in Dynamic Test Fixture
  - Integrated Weapon
- Fired approximately 400 rds to date
  - Validated ADAMS kinematic model
  - Resolved issues via combination of modeling and test data
  - Repeatable successful burst fire operation

#### Serial Number CT2

- Incorporates design mods based on CT1 experience
- Will utilize Optimized Ctg
- Hardware in-work















### Lightweight Small Arms Technologies Caseless Weapon Activities



Lightweight Small Arms Technologies (LSAT)

#### Design Status

- Developed design which maximizes commonality with CT weapon
- Evaluated:
  - Chamber sealing and lock options
  - Firing pin arrangement
  - Weapon powering approach
  - Packaging for unique ammunition free volume requirements

#### Testing Status

- Utilized residual caseless ammunition from ACR program to support early weapon component design evaluations
- Completed firing evaluation of chamber sealing concepts for effectiveness and durability
- Developed firing fixture for evaluating caseless ammunition thermal outputs









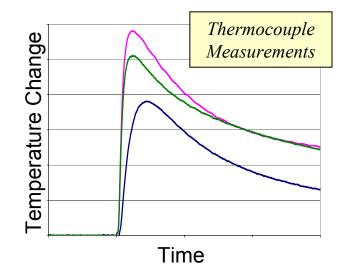


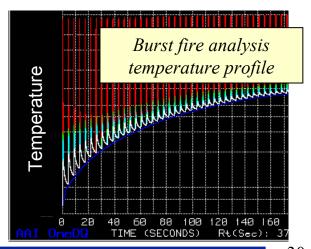


# Lightweight Small Arms Technologies General Weapon Technologies- Thermal Management

AAI

- Objective- Develop thermal management technologies applicable to caseless weapon action components and CT/CL barrels. Technology focus areas:
  - High heat capacity materials
  - Insulating coatings/materials
  - Combustion thermal input reductions
- Completed Activities
  - Extensive review of literature and candidate material data
  - Characterized caseless ammunition thermal inputs to weapon
  - Developed and validated thermal analysis models (cooperative effort with Benet Labs)
  - Selected chamber and insulator materials for performance testing using caseless ammunition thermal measurement fixture













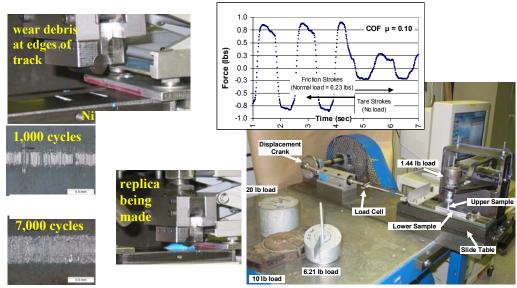


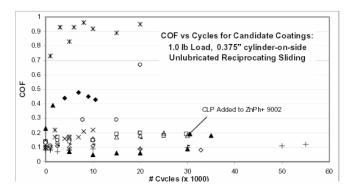


# Lightweight Small Arms Technologies General Weapon Technologies- Lubricious Coatings



- Objective- eliminate or reduce need for weapon lubrication
- Completed extensive tribological testing of candidate lubricious coatings
- Utilized a variety of interface geometries and loading conditions
- Selected implementation approach

















# Lightweight Small Arms Technologies Supportability Activities



- Supportability Focus
  - Evaluate technology implementation considerations
  - Fully integrated with development effort
- Key Activities Currently Underway
  - Logistics Support Analysis- Level of Repair analysis, Life Cycle Cost analysis, O&M task identification
  - Reliability, Availability, Maintainability- Failure modes and effects analysis, reliability tracking
  - Training analysis and materials- Training concept, training task analysis
  - Human System Integration- Human factors design support, fightability assessment, shootability assessment, system safety evaluations













### Lightweight Small Arms Technologies Summary



Lightweight Small Arms Technologies (LSAT)

- System design meets all program requirements:
  - Exceeds weight goals
  - Improves lethality
  - Improves logistics
  - Improves ergonomics
  - Maintains comparable production costs
- Maintaining parallel, synergistic Cased Telescoped and Caseless development plan
  - Emphasizes commonality
  - Reduces program risk
- Scalable design provides significant modularity and commonality
- Cohesive Government/industry team ensures success in development, user acceptance, and production

Comments/Questions?















### PEO Ammo

### MISSION

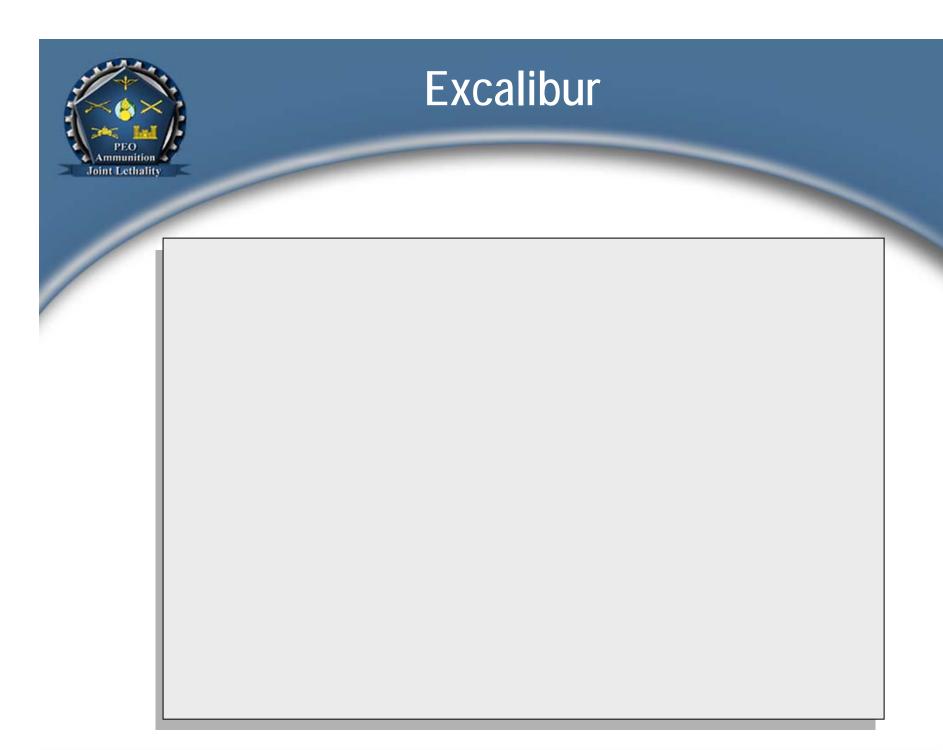
Develop and Procure Conventional and Leap-Ahead Munitions to Increase Combat Power to Warfighters





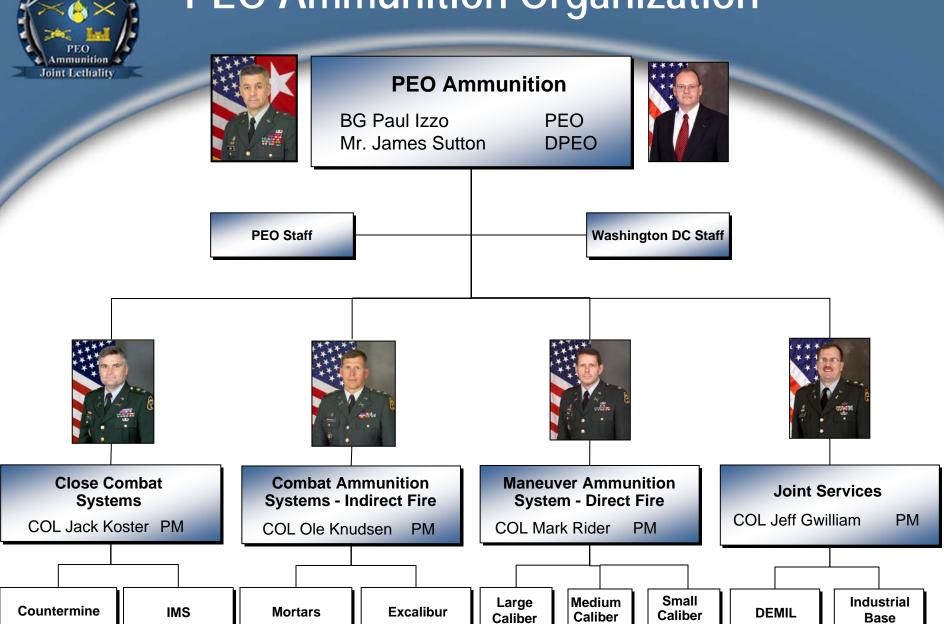


- Get PGM's & Smart Weapons to Warfighters
- Improve and Sustain the Conventional Stockpile
- Satisfy the Customer, Achieve Excellence
- Grow World-Class People and Teams





### PEO Ammunition Organization



### Single Manager for Conventional Ammunition (SMCA)



#### **SMCA Mission:**

(DoDD 5160.65 14 Apr 04) Manage DoD conventional ammunition, personnel and training functions



(DoDI 5160.68 22 Dec 03) 15 SMCA Mission functions



(DoDM 5160.65M) **Under revision** 



- **Procurement**
- Inventory
- **Demil**

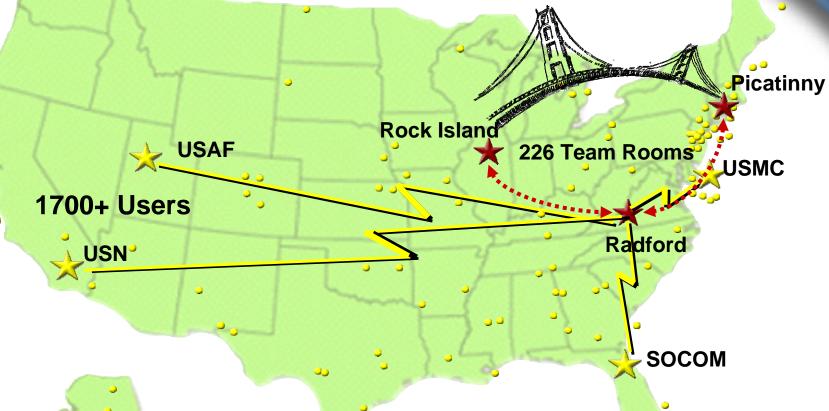






### **Ammunition Enterprise Portal**

- ✓ Bridge Across Ammunition Enterprise Sites
- √ Face to Joint Customers





**Established in 2004** 





### Strategic Thrusts

#### **PEO**

- Systems Contracting
- Permeate Six Sigma/Lean into our business
- Strategic Plans
- Industrial base modernization
  - Center for Manufacturing Science
- Engineering initiatives
  - Common technologies & components for insertion into families of munitions
- Ammo Portal
  - Integrated business environment
  - Integrated engineering environment
- Modeling & Simulation
  - Training, Lethality & Force effectiveness
- Demil
  - New technologies/methodologies to address constraints
- Smart Munitions
  - Excalibur, PGMM, PGK, MRM, IMS

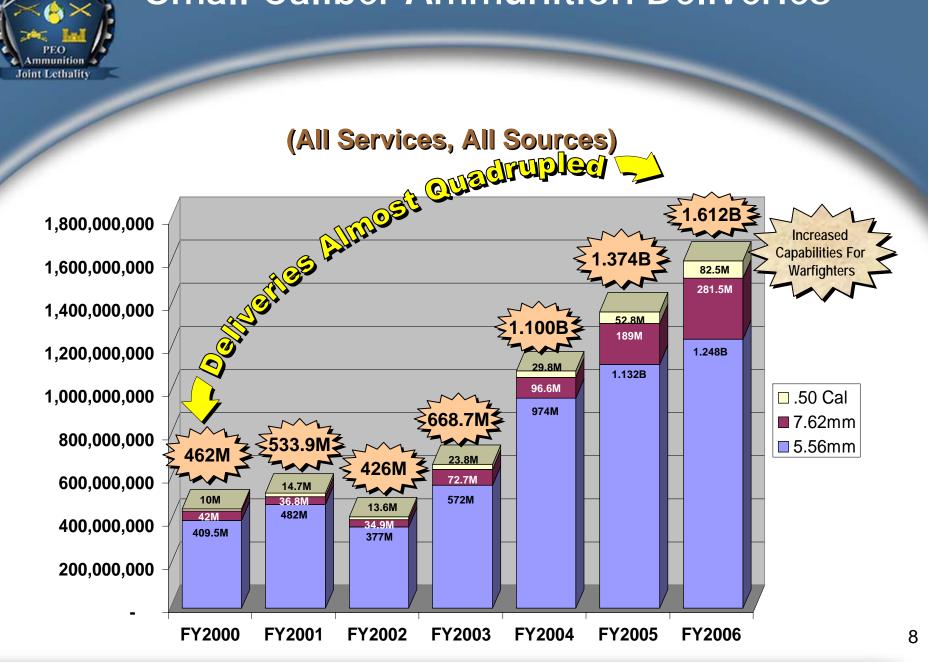








### **Small Caliber Ammunition Deliveries**





### FY06 Challenges

#### Industrial Base

- Depleted Uranium
- Implementing BRAC
- Insert new technologies into aging munitions and Correlate with new manufacturing methodologies
- Balance Industrial Base modernization with acquisition

#### Demil

- Critical Space Shortage
- Need new technologies/methodologies to address problem

#### Insensitive Munitions

- PEO Strategy approved by JROC
- JROC questioning requirements: Is it a bridge too far??

#### Smart Munitions

- Excalibur, PGMM, MRM, PGK
- Large Caliber, Medium Caliber, Small Caliber



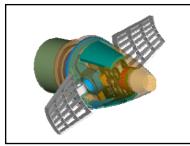


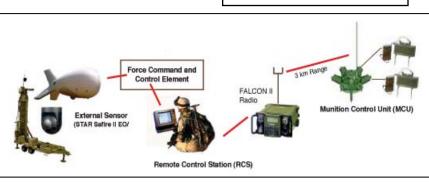
### The Future is Here



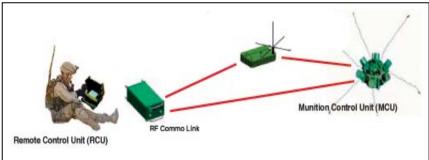












# Joint Services Small Arms Systems Annual Symposium Albuquerque, N.M. May 18, 2006

**Mounts and Ancillary Equipment** 

#### SERMON ON THE MOUNT

**Past, Present and Future** 

Presented By Mr. Dick E. Swan
Atlantic Research Marketing Systems (A.R.M.S.)

### **Abstract**

A brief history of where and how we were mounting early aiming devices. How new mounting systems and devices evolved.

How developers for fire control are governed by weapon surface/s, ergonomics, and tactics.

Modularity was not always understood or practiced. Lasers were not always around, understood nor wanted. Dovetail rails were a hard sell at one time.

Why weapons designers need to work with optic/laser/NV and mount makers; before, during, and after development.

Why all branches of the services, must have their specific needs in fire control be addressed in common interfacing. Human engineering factors.

Should we rely on electronics alone for hand held point of aim weapons?

What needs to be considered for providing reliable power to future weapons - is a battery the only way? Built in devices vs. field interchangeable systems. Importance of helping weapons run cooler thus longer, and keeping barrels free of direct attachment of rails and mounted devices. Helping electro-optic devices run longer without failures due to weapon heat and vibrations.

The common interface for mounting devices to man portable weapons, is dictated by the most common weapon used by the warfighter. In this case, the M16 A1,A2 with its carrying handle channel mount configuration.



The Proposed Kodak Optical Sight System

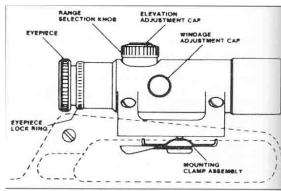


379. Ciosenpi of a civilian AR-15 (model SP), filted with experimental Kodak.
3.51. Optical Sight.
Left: late model sight in Colt-adopted ARMS scope base.
Right: outlier model sight fined with Kodak's 12-ce., slide-on "Night Adapter"
with lithium-powered image intensifier, capable of presenting a 2x2-meter



target area at ranges up to 500 meters. Note the early mount, which gave way to the ARMS design (above). Rodak has developed a unique intert-modding technique which intends polished but not edge-trined lenses, properly positioned, within the plastic body of the unit itself, thus dramanically reducing the cost of quality military optics.

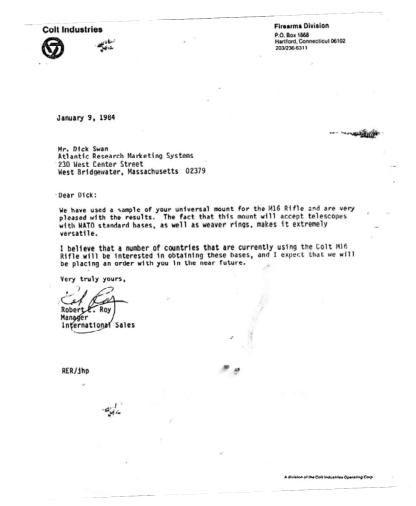


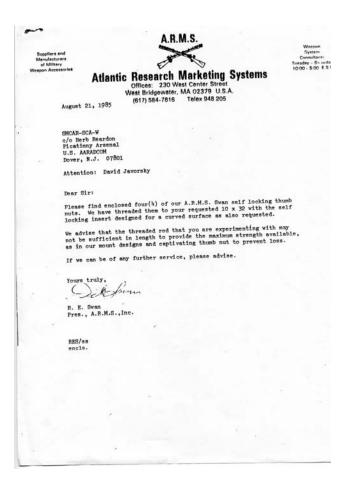


556. A line drawing right side view of the Colt 3x20 and 4x20 scope, showing nomenclature.

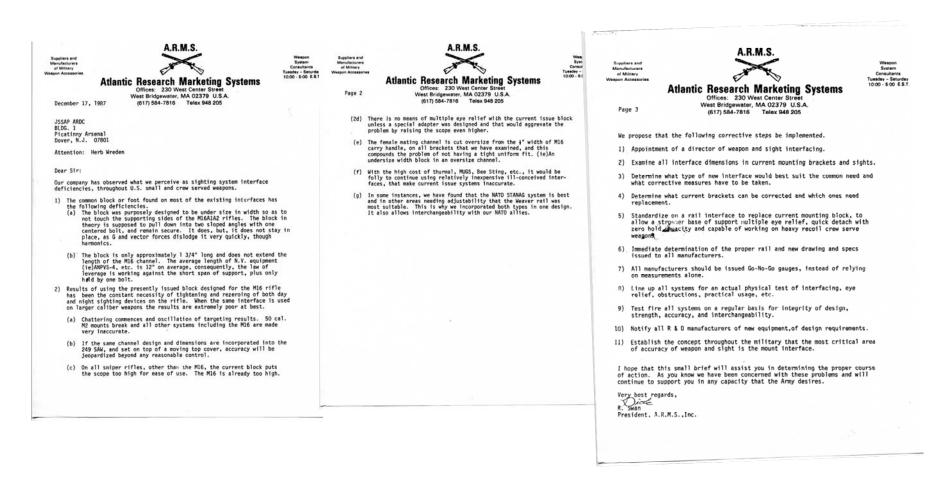
The sight adjustments may be made with the rim of a 5.56mm cartridge.

In 1983, A.R.M.S. had developed a dovetail rail similar to the commercial Weaver style, but with significant variations to what was available on the commercial market. Some of those variations included, standardizing on a dovetail dimension for its product line, rectangular cross notches vs. the Weaver half round notch, a 3/8" wide channel thru the center top of each dovetail rail, and when practical, the notched channel was set at a STANAG length with holes placed at either end to facilitate the mounting of STANAG optical devices. In 1983, A.R.M.S. also developed a self-locking thumbnut design, that was used in the carrying handle optic rail mount. That self-locking feature is currently used to secure the M16 carrying handle to the flat top receiver.





In late 1983 and on, A.R.M.S. started to receive requests from individual military personnel, for the ability to mount scopes to their carry handle M16 rifles. The integration of rails to replace carrying handles and other experiments with other weapons, showed a clear need to develop something better than the channel mount, from many sources.



In the late 80's a lot of experimentation was being conducted in regards to rail interfacing vs. channel mounting. A much younger Gary Houtsma from Picatinny's Future Weapons Branch, is shown visiting A.R.M.S. facilities with a very special weapon system. Dovetail dimensioning, receiver height placement and notches to facilitate various known aiming devices, were experimented with. Attachment devices used by A.R.M.S. at the time, included the self-locking thumbnut and the then new A.R.M.S. throw lever system.

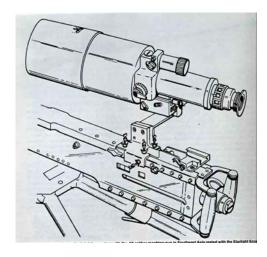








The transition from a channel carry handle mount, to a dovetail rail mount, was a daunting task due to the vast array of weaponry and sighting devices that had to be considered, if interchangeability was also to be realized.









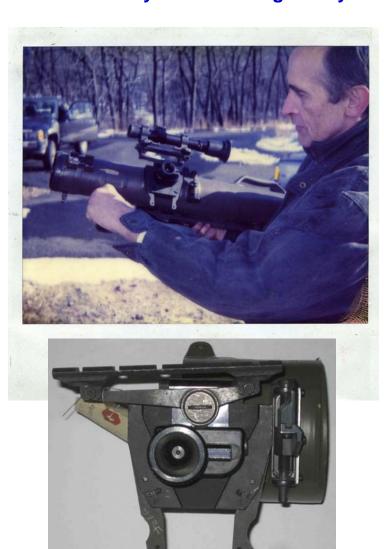
Squad auto weapons created more mounting problems. Because the top cover had to be raised to load the weapon, mounting the optic so the objective lens didn't become damaged from hitting anything forward of the receiver.



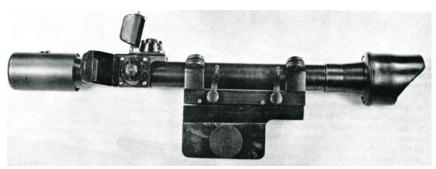


Air defense and anti-armor weapons, also had to be able to interchange aiming devices that were available to the M16 weaponry. A stinger missile launcher, AT-4, and Carl Gustav are exampled, with A.R.M.S. mounting variations that provided commonality for interchangeability.





One of the most common but difficult weapons at the time to provide mounting ability to, was the M14. Because of its unusual side mounting provision and not having a straight line stock like the M16 rifle, height placement and eye relief were a challenge for practical interchangeability.









Creating interchangeability between weapon types, different receivers, various interfaces on the bottom of optics, variations in eye relief, etc. was a difficult transition. A.R.M.S. 1990 photo.



Top center photo – Colt ACR receiver with half round notches, unmachined ACR receiver forging. Notice that the carrying handle ability was retained in the forging. The pencil driven into the bottom of the half round notch was a demonstration by yours truly that the next forging should have the dovetail raised .100 higher for a proper dovetail.

A.R.M.S. mounting experiments included converting M16A1 receivers to a flat top configuration. A day vision and N.V. throw lever attachment and throw lever QD rear sight.







Two Thermal housings before being converted from a channel carry handle mount to dimensions better suited for rail interface needs.



Highly advanced weapon and aiming systems became more easily accomplished with the new rails and throw levers, such as this 1991 photo shows with the A.R.M.S. Rigid Frame.



Lasers working from a carry handle mount, compared to modern day mounting of much more capable laser devices.





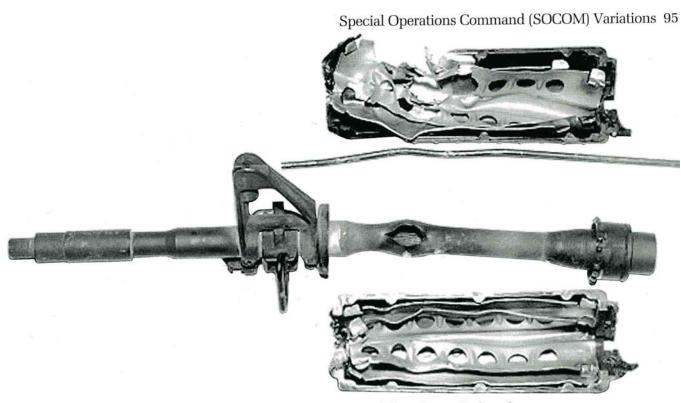
Lasers keep on getting smaller, more capable, and headed to a common interface.



A.R.M.S. experimental carry handle and flat top receiver mounting for lasers, etc. that are only powered via an auxiliary box to the left of the receiver, that can also accommodate a miniature dynamo power up.

#### **FREE FLOAT!**

The heat transfer of up to 900° hot gun barrels, is best avoided by not attaching (anything) to the barrel. Allowing good venting and not trapping heat from radiating away, will allow a weapon to survive longer.



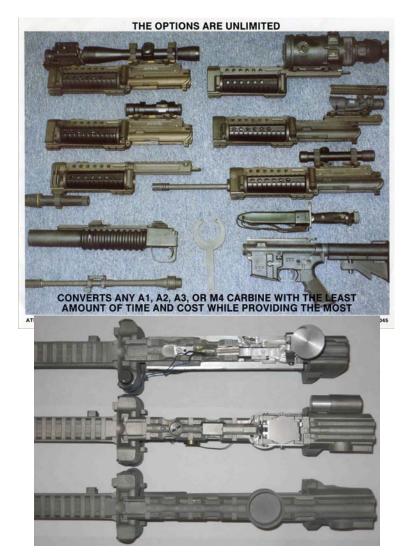
115. Another example of a barrel failure due to the barrel reaching its transformation temperature, which softens the metal.

courtesy United States Special Operations Command

In the early 1990's A.R.M.S. designed a free float barrel and rail system. Some of the features included a Q.D. laser ability built in flip up optics, and integral electronics power supply.







A young me experimenting with reasons why the carry handle had to go, and some of the ways it was accomplished. The Canadian military were the 1<sup>st</sup> to adopt the A.R.M.S. established dovetail dimensions for their receiver; followed by Colt and Picatinny. The channel in the center was eliminated on the receiver as it was determined it looked too much like a pineapple grenade, next to a shooters head. All of the notches on top of the current receiver were added as a temporary accommodation for the various optics being evaluated, and having different eye relief's and crossbar requirements.

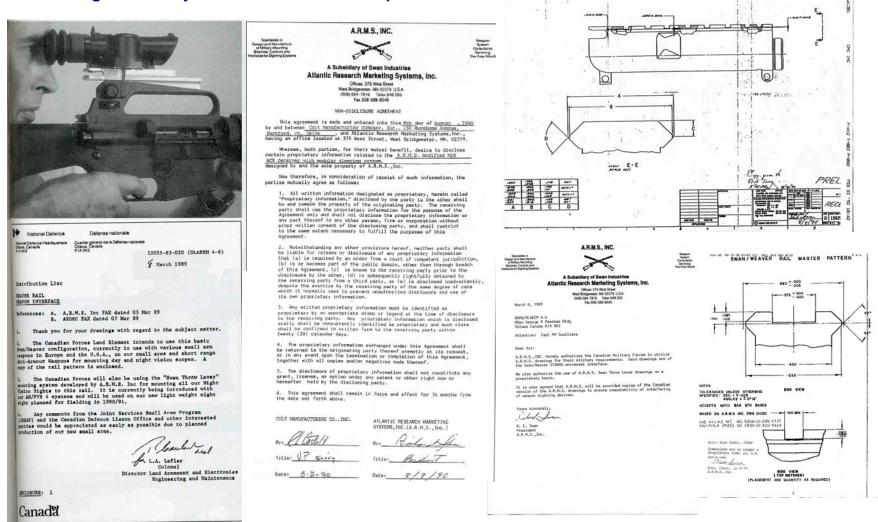


Photo on the left demonstrates that we will try mounting any device to help our soldiers.

Photo on the right shows just some of the ancillary equipment the military currently make available to attach to the M16/M4 as needed by the warfighter.

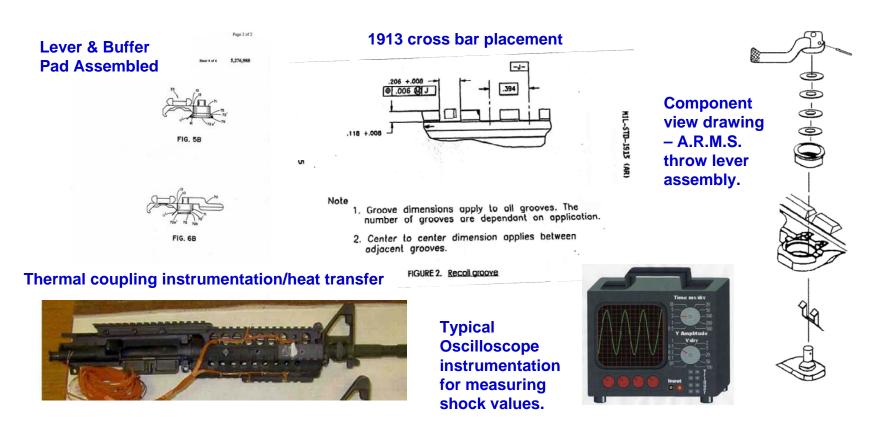




#### Hard Mounting vs. Soft Mounting.

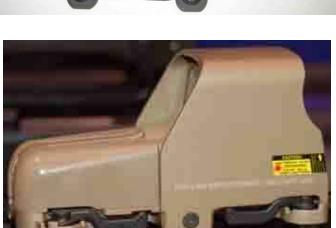
A.R.M.S. developed the throw lever concept in the late 1980's to provide a mount attachment that would provide a real repeat on/off zero. All other mounts used a side to side direction of force, that disrupted windage when a knob or nut was used for attachment, because of the varying degrees of force that hand tightening could not judge. The A.R.M.S. throw lever is a soft mounting system that helps eliminate shock waves to sensitive electro-optic devices, much like shock absorption springs for vehicles, and even tanks.

A.R.M.S. experimented and determined that a non-adjustable pre-selected tension would eliminate any chance of over tightening or damage to rails, and for the same reasons that the M16/M4 does not provide an adjustable gas or buffer system, as experience shows, young soldiers may likely adjust it wrong. A.R.M.S. also provided a buffer system to further protect the precision rails. The notch in the 1913 rail is designed to leave clearance so that any debris in the notch does not disrupt placement of a cross bar in the field. Once attached in the forward position of the notch, the predetermined spring loaded tension built into the throw lever will provide extended longevity to sensitive devices.



Soft mounting of devices provides an accurate QD advantage over thumbnuts and/or wrench tightened attachment. The cam surface on the A.R.M.S. throw lever assembly will not shake or vibrate loose and has proven to be snag free. A.R.M.S. has provided a lever lock ability, but to us its more like wearing suspenders with the belt. In the last 18 years, A.R.M.S. has supplied many hundreds of thousands of throw lever attachments to the electro-optical community for N.V., thermal, laser, and continue with some of the newest Government selected day optics, and many other devices not shown.



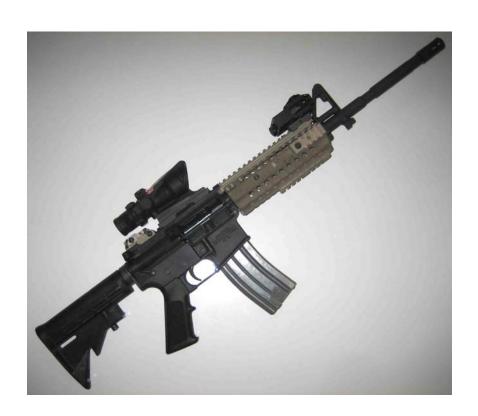


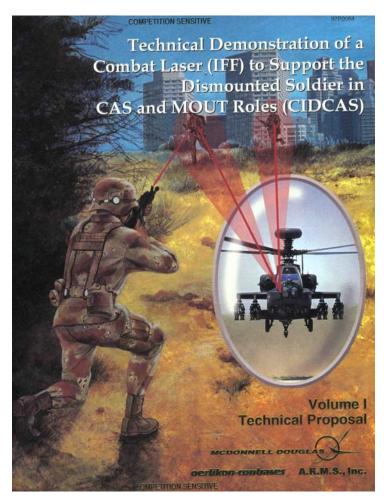




There are many good rail systems in service, the newest ones are free float. The A.R.M.S. S.I.R. System, Selective Integrated Rail, is unique that it allows rails to be added or replaced as required by technology changes and/or field repairs. The polymer lower is also unique since it does not require covers to protect against over-heated aluminum.

This 1995 A.R.M.S. poster demonstrates our continued vision of the future that will provide high tech integrated abilities to our warfighters with advanced man portable weapon systems of all kinds, and synchronized to communicate with larger support systems.





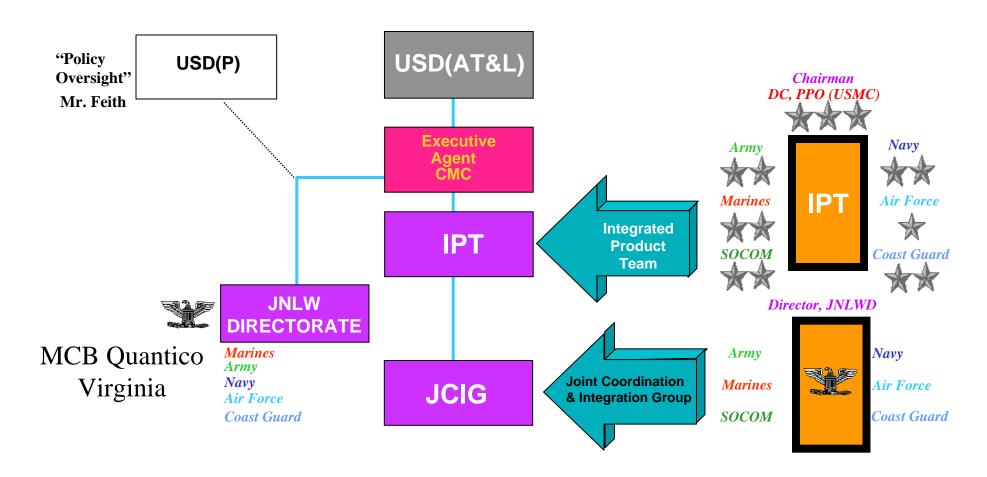
# JNLWP Update to the Joint Service Small Arms Symposium



Mr Swenson
Acquisition Division Chief, Joint NL Weapons Directorate
(703)432-0906, DSN 378-0906
kevin.swenson@usmc.mil



## JNLWP Management Structure





### **Service Requirements**

- 1. Stop / Disable / Impede Vehicles / Vessels
- 2. Crowd Control / Incapacitate Individuals
  - On Land or In the Water @ 300 Meters
- 3. Clear Facilities With and Without Entering
- 4. Deny Area / Deny Access
- 5. Determine Intent



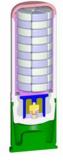
### Lesson's Learned

Focus on the Payload, Not the Launching Platform Range Similar to Lethal Ammunition Fire From Existing Platforms Break-Up NL Capability Sets Lack of NLW/C Education / Training Get NLW/C Into Senior Level PME Officer and NCO Curriculums Include in Escalation of Force (EoF) Training / Orders More MTT's for Deploying Forces Increasing Focus on MOUT Operations / Requirement's Service Desires for "Scaleable" Weapons



### **JNLWP Small Arms Interface**











Airburst NL Munitions

MK19 NL Short Range Munitions



Mission Payload Module - NL



FN-303 Projectile Launcher







Joint NL Warning Munitions



X26 Taser



## **Industry Engagement Opportunities**

#### **COTS / MODIFIED COTS:**

- JIP Semi-Annual Meeting
  - 23-24 May @ Aardvark Tactical Los Angeles, CA
- JIP Warfighter Symposium
  - Jan 07 Fort Benning, Georgia
- Doug Esposito douglas.esposito@2asc.com, (703)441-2549, Ext. 1028

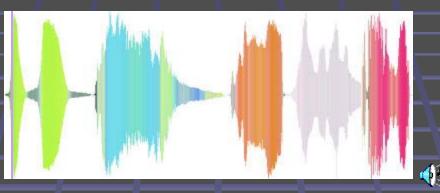
#### **DEVELOPMENTAL NLW/C:**

- Industry NLW/C Symposium
  - 1-2 November Washington D.C. Area
- MPM NL Request for Technology Development Proposals
  - 1QFY07
- JNLWP FY06/FY07 Broad Agency Announcement Through 31 Dec 06
  - Thrust Areas:
    - Extend the range and duration of personnel incapacitation capabilities
    - Vehicle / Vessel Stopping
    - Human Effects Characterization
  - FY08 Proposals Due Nov/Dec 06





# Supressors, Evolving to an Integrated Unit



# Designing with the Soldier in mind



#### Sophia Tassy

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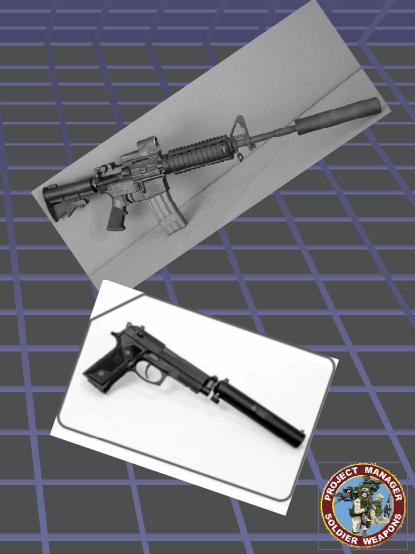




# Briefing Objectives



- Call to Industry for an Integrated Unit
- Update on FoSASProgram Activities and Timeline
- Future ProgramExpansion









The information you are about to view is intended for illustration and informational purpose only.

The Government bares no responsibility for any misuse and/or misinterpretation of any

information contained herein







# CALL for an Integrated Unit



Currently available Designs were adapted to Commercial Market and in some cases to Law Enforcement

Different models & designs, different strengths no Consistency (size, weight, flash, sound, Sights, blowback etc.)

Evaluate currently fielded weapon configurations for Design consideration

Next Generation Suppression system

Two dimensions to Integrating suppression:

- 1. An Integrated Suppressor Unit that supports the full gamut of features as prescribed in the User requirements
- 2. An Integrated Weapon system that includes suppression capabilities that meet User requirements but requires no ancillary attachment (good application may be Machine Gun)







# Design Considerations



#### <u>Gap</u>

- One multi-feature (sound, flash, etc.) Solution for suppressed weapon
- Baseline Data availability (Methodology for acquiring data)
- Performance Standards availability

#### **Improvement opportunity**

- Blowback Reduction (Gas, Debris, ground disturbance etc.)
- Suppressor Induced Weapons modifications (replacement compensator, barrel etc.)
- -Size & weight
- -Heat / Cooling
- -Sight compatibility
- -Method of attachment
- -Loosening, Alignment

#### **Supportability**

#### Logistic

- Spare Parts management (washers, sights, flash compensator, etc...)
- Suppressor cleaning vs. Weapon cleaning
- Maintenance requirements
- -Storage and Handling
- -Life expectancy of Suppressor (Life cycle mgt –pats vs. system)







### Need Statement = User Requirements



	Threshold (t) and Object	ctive (o)	
Attribute		evelopment	Objective
Sound Reduction	The suppressor shall lower the average peak sound pressure level 10db when compared with the average unsuppressed weapon, current service pistol; M4 Carbine; M16A2/4 Rifle (T).		The suppressor shall lower the average peak sound pressure level 20 db when compared to an unsuppressed weapon (O).
Flash Reduction	The suppressor shall be designed to reduce flash, firing signature visual, and blooming effect of the weapon such that it is less than the existing weapon flash hider. (T)		No flash visible to the naked eye during day and night conditions from a distance of 100 meters.(O)
Modification/ Compatibility Blank Firing Adapter MILES M9 bayonet	If mounting the suppressor requires changing the existing weapon flash compensator, the new flash hider/muzzle compensator shall be compatible with the current blank firing adapter, current MILES system and the current M9 bayonet (T)		Suppressor shall attach without modification to the existing flash hider (O)
Muzzle Velocity	The suppressor shall not reduce the muzzle velocity of the round more than 2% compared to the baseline system.(T).		The suppressor shall not reduce the muzzle velocity of the round (O).
Sight Compatibility	The suppressor must not interfere fitting or use of any of the current weapons optical or iron sights, air lights or illumination devices (for example: M68, M145, PEQ-2, PAPAS13,etc) for M4/M16 and M24	tly issued ming AQ-4,	The suppressor must not interfere with the fitting or use of pistol optical or iron sights, aiming lights or illumination devices (O).  There should be no change in zero of optics or sights on any weapon systems when fired suppressed or unsuppressed (O).
Ground disturbance	The suppressor shall be designed reduce visual firing signature such disturbance of dust, foliage, and of that it is less than the base line we	h as lebris so	No ground disturbance visible to the naked eye during day and night conditions from a distance of 100 meters.(O)
Immersion	The suppressor shall require no metwo second drain time to fire after submersion in , and removal from seawater. (T)	r full	Zero second drain time to fire with no special manipulation of weapon is desired other than firing mode selection (O).
Blowback	The suppressor when attached sha create any discernable blowback form of carbon, soot, or flash tow operator (T).	in the ard the	T=O
Protective Coating	All suppressors will be corrosion, abrasion, impact and chemical resistant.(T)		T=O
Cleaning Kit	The suppressors will be designed manner that will permit cleaning the Warfighter's individual clean kit.(T)	utilizing	T=O







# Technical Aims/Design Objective



#### FoSAS Test subjects:

- M4/M16 (5.56mm) using M855 ball ammunition -
- M9 (9mm) using M882 ball ammunition -

Great Turnout 11-M9 and 11 M4/M16 suppressor models submitted

	Chara	acter	istics
--	-------	-------	--------

Baseline M4-M16/M9

Sound Level

Flash size

Dispersion

Muzzle Velocity

Recoil

Toxic Fumes

# <u>Desired</u> Performance

<=140 db

Below baseline

Below baseline

Below baseline

Below baseline

Below baseline

















# Test Parameters



### Technical Assessment - ATC

#### Objective:

Evaluate
Advantages
and/or
disadvantages
of Suppressors
in
operational
exercise

#### **SAFETY Test**

	Rounas
<u>Subtest</u>	Required
Inspection	N/A
Velocity	40
Sound Level	30
Muzzle System Flash	30
Reliability/Durability	5,000
Immersion	45
Mean Point of Impact Sh	ift 10

#### Bid Sample Base:

11-M9 (77)

11-M4/M16 (77)

#### Technical Test:

	Rounds
Subtest	<u>Required</u>
Inspection	N/A
Toxic Fumes	30
Low Temperature	500
High Temperature	500
Sound Pressure Level	30
Rough Handling	N/A
Muzzle System Flash	30
Accuracy Dispersion	30/90
Accessory Compat.	N/A
Ammo Compat.	N/A
Immersion	45
Reliability/Durability	5,000







# Human Factors Engineering

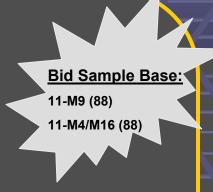


User Assessment -SBL



Determine Test system suitability in the execution of the following tasks

- New Equipment Training
- Close Quarters Marksmanship
- Urban Obstacle Course
- Individual Movement Technique Course
- Combat Pistol Qualification Course
- Reflexive Fire
- M4/16 Zero and Qualification Range





- 2. Determine ability of Soldier to engage targets with reduced risk to hearing and without being detected by sound or muzzle flash.
- 3. Determine ability of Soldier to maintain Command and Control and not be affected by blooming effect, when firing within buildings and especially at night.
- 4. Determine ability of Soldier to maintain maneuverability and survivability in more open terrain, without compromising location through muzzle blast disruption to vegetation/foliage or signature created by dust, sand and snow disturbance.
- 5. Determine and compare durability and reliability of suppressed weapon
- 6. Determine and compare accuracy of soldier/weapon system at know distance ranges (10 rds→100 m, 300m)

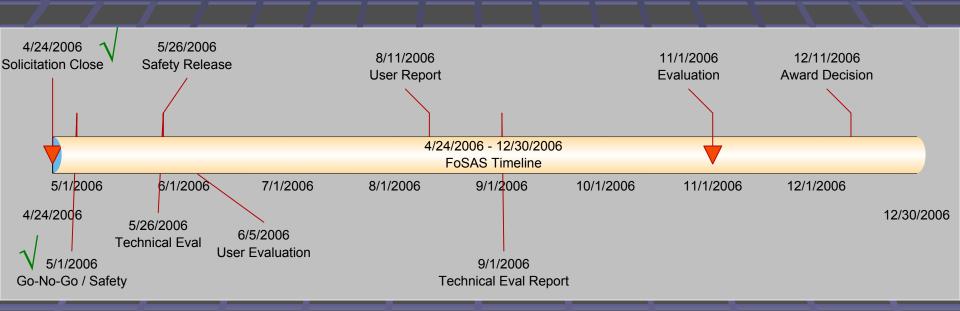






# FoSAS Program Update







Disclaimer:

Information contained in this slide is speculative and subject to change





# Program Expansion & Direction



- Expansion of FoSAS to Include M249
- Joint effort with USMC on FoSAS
  - Will be monitoring User Eval
- Rapid fielding effort on the way for M14 and M24
- Survey for M240 and M2











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# SOPMOD PROGRAM OVERVIEW

# National Defense Industrial Association Small Arms Symposium



17 April 2006





# **Agenda**



- SOPMOD Program Overview
- Acquisition Top Map
- Miniature Day Night Sight (MDNS) Development
- Weapon Shot Counter (WSC) Development
- Weapon Shock Simulation
- New Initiatives and Business Opportunities





## **SOPMOD Mission**





The SOPMOD Program

Management Office at NSWC

Crane, IN, will provide

standardized, versatile weapons
accessories to meet needs across

SOF mission scenarios.

These accessories will increase operator survivability and lethality by enhanced weapon performance, target acquisition, signature suppression, and fire control. SOPMOD PMO will provide these accessories when they are operationally suitable, affordable, sustainable, and funded.







## SOPMOD Client Weapons

SPECIAL STATES STATES

**SOPMOD ORD 5 - Core Small Arms** (Threshold) ... **Design For Use On:** 

M4A1 Carbine M203 Grenade Launcher

**ORD Annexes - Additional Weapons** (Objective)

....Harden For Use On, and possibly develop versions for:

SCAR

CQBR (Mark 18)

MK46 LMG / M249 SAW Machineguns

MK48/ M240-N/M240/M240-B Machineguns

M14 and Mark 14 Enhanced Battle Rifle

**AK-47/AK74 Series Assault Rifle** 

Mk-19 40mm Machinegun

M2-HB .50 Cal Machinegun

**M72 LAAW** 

AT4-CS

**MAAWS** 

MK11, MK12, MK13, & MK15 Sniper Rifles M-24 Sniper Rifle

SOPMOD SOPMOD

Unclassified

**SOPMOD Weapons of Interest** 

Limited Interest – Generally Covered by UNS (AN/PVS 22), MUNS, & DUNS





### Capabilities Required



- Standardized versatile weapons accessories
- Modular- meets needs across SOF mission scenarios
- Increased operator survivability and lethality by enhanced target acquisition, signature suppression, and fire control





- Evolutionary Acquisition Subprograms:
  - Block I (Plus Platform Mods and Phased Replacements)
  - Block II (New and Combined Capabilities)
  - Block III (Emerging Capabilities)





# **Crane Task Organization**













SOF LCSM

Fielding & Sustainment

SOF Small Arms Program Group

RD&A & ISEA



RD&A & ISEA

**SOF Weapons PMO** 





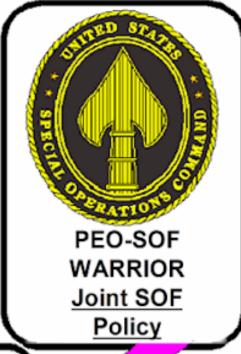
### **SOPMOD Guidance**





**Policy** 









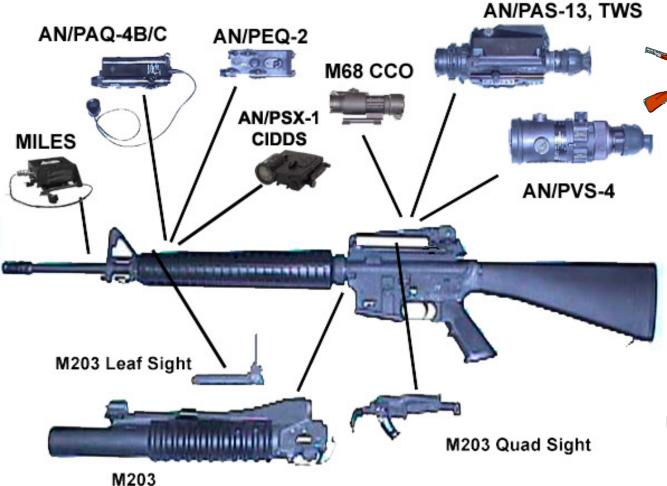




### **Army Modular Weapon System (MWS)**









M16A2 -- TM 9-1005-319-10

## **Frequent Coordination**





# Quality

### SOPMOD, as part of NSWC Crane, is ISO 9001 Certified



Our Quality System is a set of formally documented activities that are carried out to ensure that we satisfy our customers' requirements.

**Our Quality System is based** on, and officially certified to, the requirements of ISO 9001-1994, an international standard for quality assurance in design, development, production, installation and servicing.









### **SOPMOD Sub-Program Structure**

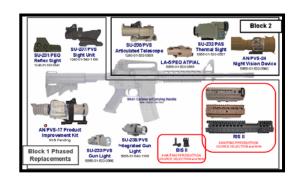




### SOPMOD Sustainment



### Miniature Day/Night Sight (MDNS) Development



### Weapon Shot Counter (WSC) Development





### **SOPMOD Block 1**







# SOF-Peculiar M4A1 Carbine Product Improvements









# USSOCOM PEO-SW / SOPMOD Accomplishments (1)





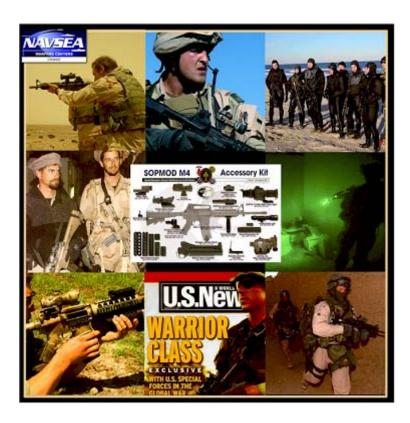


- Joint Weapon Accessory System Currently Used By Army Special Forces, Army Rangers, Navy SEALS, Air Force Special Tactics & USMC Special Operations.
- Integrated Day And Night Aiming and Signature Suppression System
  - 20 Varieties Of Subsystems
  - 6 Varieties Of Minor Items And Parts Sets
- Miniaturized Lights, Lasers, Optics, Image-Intensification Night Vision, Thermal Imaging, And Sound Suppressors



# USSOCOM PEO-SW / SOPMOD Accomplishments (2)





- **●** 105,876 Total End Items Fielded To Joint SOF Forces-Currently Used In GWOT, with 3,317 End Items Currently In-Transit
- Over \$128 Million Awarded On Contracts To Date
  - Additional \$104M Programmed For Future Fielding
  - 10 Emerging Technology Subsystems approaching FRP
- Cradle-To-Grave Life Cycle Support To Customers, Controlled Through DoD Registry, Sustained Through A Joint Special Operations Logistics System
- Full Program Under One Roof at NSWC Crane.







### **SOPMOD Sustainment Sub-Program**

### **DESCRIPTION**



#### PERFORMANCE CHARACTERISTICS

- Program Status: **GREEN**
- standardized, versatile weapons accessories to meet needs across SOF mission scenarios
- increased operator survivability and lethality by enhanced weapon performance, target acquisition, signature suppression, and fire control

**KEY MILESTONES/ ACTIVITIES** 

### APPROXIMATE BUDGET PROFILE

- FY-95 to Present, Invested:
  - → \$9M R&D
  - > \$128M Procurement
  - **≫** \$13M O&M
- Planned Sustainment of Current and Future Systems through FY11:

### > \$34M O&M (Changing!)

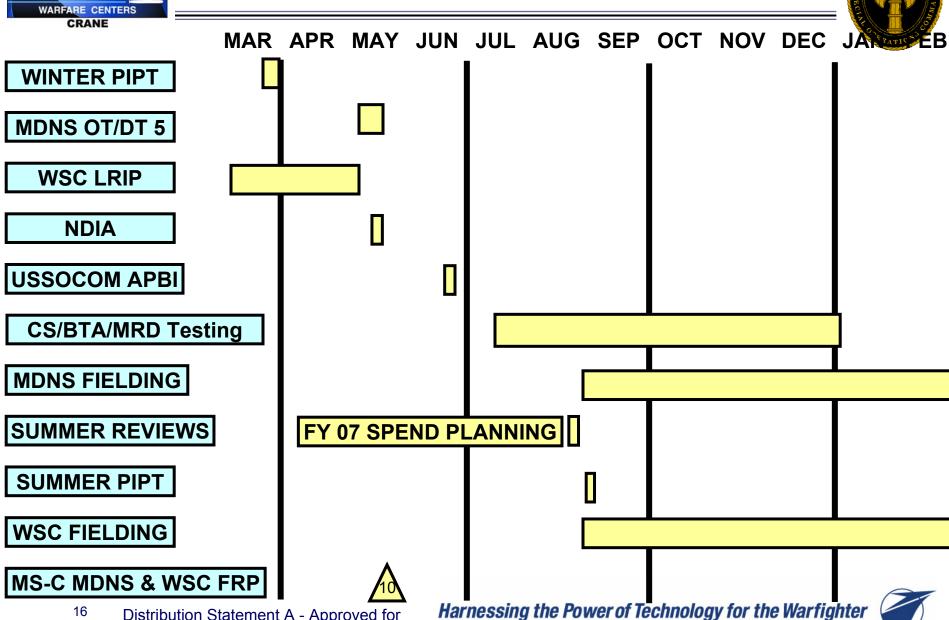
# Product Improvements Sustain Block 1 Sustain Block 2

<u>Distribution Statement A</u> - Approved for public release; distribution unlimited.



### **SOPMOD 06 MACRO CALENDAR**

**Unclassified** 







# SOPMOD ACQUISITION TOP MAP

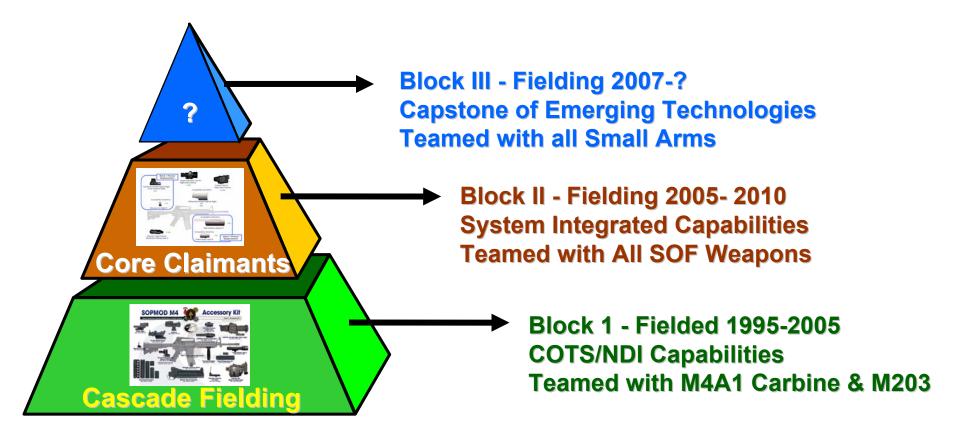
17 May 2006





### TOP MAP STRATEGY







### TOP MAP STRUCTURE



- Overview Top Map Shows Entire System at a Glance
- Five Detailed SOPMOD Accessories Top Maps Show Main Subsystem Categories
  - 1. Carbine Improvement Subsystems
  - 2. Passive Day Aiming Subsystems
  - 3. Passive Night Aiming Subsystems
  - 4. Active Aiming Subsystems
  - 5. Weapons Shot Counter Subsystems





# SOPMOD ACQUISTION TOPMAP OVERVIEW



### **Existing Systems**

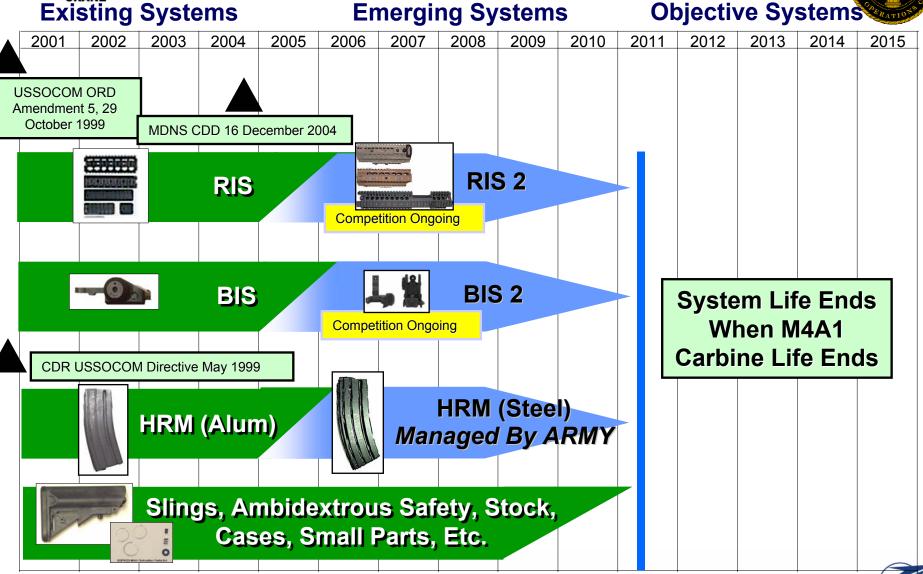
### **Emerging Systems**

### **Objective Systems**

Existing Oystoms								Otolli	•		Objective Oyeteme			
2001 20	002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SOPM	OD	ACC	ESSC	RY K	IT OV									
SOPMOD	Inc	rement	#1 (19	94-2007	7+)									
SOPMO	M4 3	Accessor	y Kit											
	1	- Table 4		SOP	MOD	1								
Alle:	4	I.		1994	-2012									
	1	750	-100-				DUSTIFED SUBSTITUTE AND	SU-200-PVS SU Southers Telescope Take-on Goldens LA-SPEC ATPLA and it Goldens	Block 2  Block 2  Block 2  ANYE Of ANY	Ş	OPMO	)D 2:		
								MDNS & WSC						
						Bio Re	ANPYS-17 Product Improvement XX stall Product Ck 1 Phased placements Our Light	SU COM PVS SU COM PVS Light Uight SUS CV (40 From light Committee (140) Fro	PRE II  AND THE CONTROL OF CONTRO	2	004 <b>-2</b>	0124		
												SOPN	MOD 3	
											2	008-O	nward	
	201		4.0.0		411.1									
SOPMOD 1 & 2 Compatible With both M4A1 Carbine and SCAR														
						0.0			4.1	L. VAR				
						30		) 2 Coi	mpatit	ne Wi	th All S	SOF W	eabo	115



# SOPMOD ACQUISTION TOPMAP Carbine Improvement Subsystems

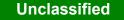






# Miniature Day/Night Sight (MDNS) Development







### **MDNS Goals**



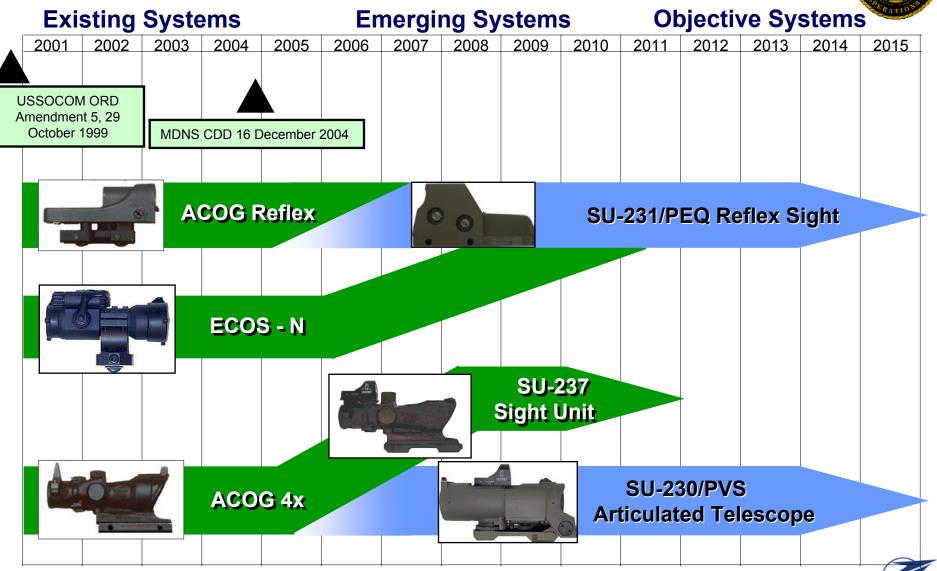
- Based on Unrequested FY02 Congressional Plus-Up
- Update Aging Technology on Current SOPMOD Items
- Address Possible Improvements in Current SOPMOD Kit Items
- Miniaturize and Ruggedize SOPMOD
- Integrated System Approach
- Encourage Innovation through Competition
- RDT&E + Modified NDI: Best of Both Worlds
- Meet Objective Fielding Requirements for SOPMOD Kits





# **SOPMOD ACQUISTION TOPMAP Passive Day Aiming Subsystems**

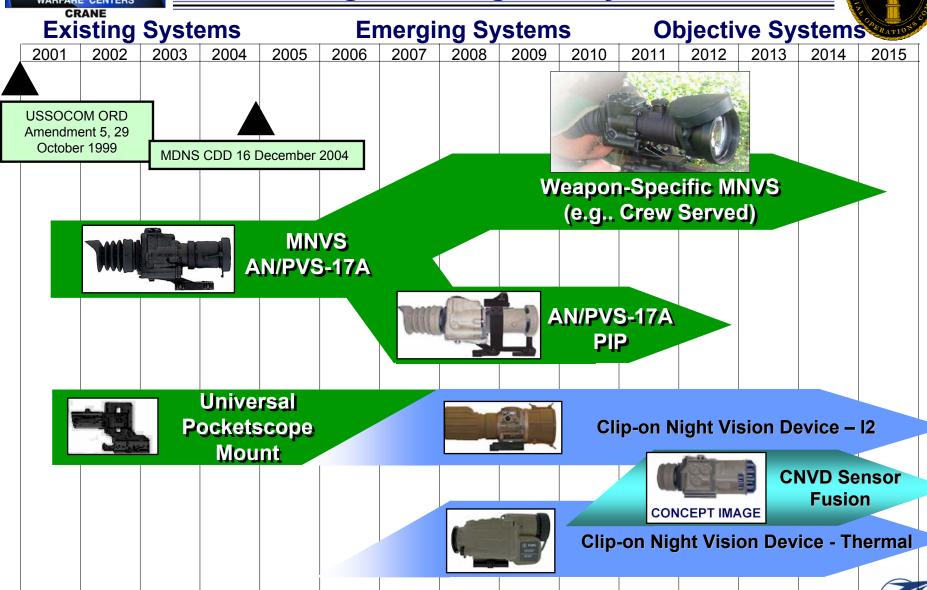
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# **SOPMOD ACQUISTION TOPMAP Passive Night Aiming Subsystems**

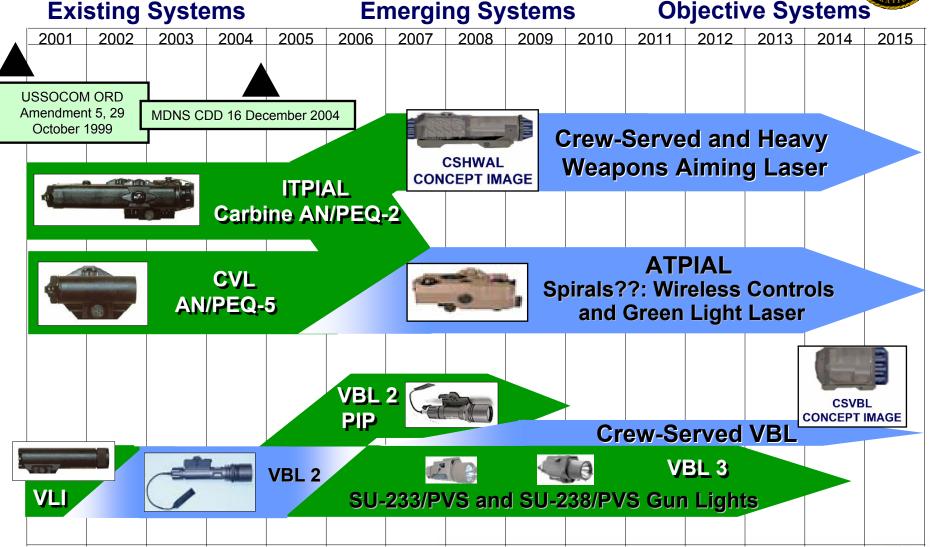
Unclassified





### SOPMOD ACQUISTION TOPMAP **Active Aiming Subsystems**

**Unclassified** 



Harnessing the Power of Technology for the Warfighter





# Miniature Day/Night Sight (MDNS) Development - OVERVIEW



### **DESCRIPTION**



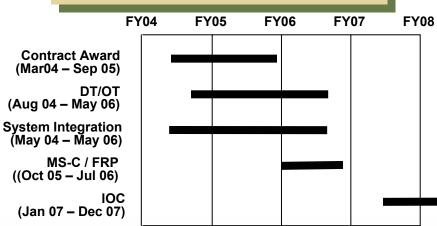
#### PERFORMANCE CHARACTERISTICS

- Sub-Program Status: GREEN
- Capability / technology upgrade to all SOPMOD day / night sighting subsystems for phased-replacement
- Improved weight, ruggedness, and zero retention
- New and combined capabilities: miniature thermal sighting, combined optics and lasers

### APPROXIMATE BUDGET PROFILE

- FY-06 to FY11 Programmed:
  - → \$0.8M R&D
  - >> \$89M Procurement

### **KEY MILESTONES/ ACTIVITIES**





# Rail Interface System II (RIS II) OVERVIEW











- Floating Rail Concept
- Floating Grenade Launcher Capability
- Improved Shooting Accuracy
- 3 Contracts Awarded in March 2005
  - N00164-05-D-4863 (A.R.M.S.)
  - N00164-05-D-4864 (Daniel Defense)
  - N00164-05-D-4865 (Knight's Armament)
- Final Production Down-Selection In-Process





# Backup Iron Sight II (BIS II) OVERVIEW









- Program Status: GREEN
- Improved Aperture Flexibility
- Improved Set Position Features
- 2 Contracts Awarded in September 2005:
  - N00164-05-D-8559 ((Knight's Armament)
  - N00164-05-D-4864 (A.R.M.S.)
- Final Production Down-Selection In-Process







# SU-231/PEQ Reflex Sight OVERVIEW





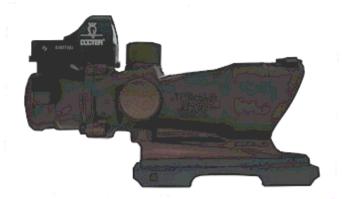
- Night Vision Compatible
- Increased Optical Field of View
- Holographic Technology
- Based upon EOTech 500 Series HWS
- 0.5 MOA Adjustments
- DL 123 Battery Powered
- Throw-Lever Mounts
- Contract N00164-04-D-4832
  Awarded to EOTech
- Possible Spiral Developments Include Crew-Served Sizing and Ranging Reticles





# SU-237/PVS 4X Dayscope w/ MRD OVERVIEW





- 4X Magnification
- Incorporates Miniature Red Dot for CQB
- Improved Reticle Illumination
- 0.5 MOA Adjustments
- Throw Lever Mount
- Possible Spiral Developments
- Contract N00164-04-D-4834 Awarded to Trijicon





# SU-230/PVS 1-4X Dayscope OVERVIEW





- 1X 4X Switchable Magnification
- Switchable CQB/Open Air Illuminated Reticle
- Compatible with Miniature Red Dots
- Adjustable Reticle Illumination
- 0.5 MOA Adjustments
- Spiral Development Potential
- Throw Lever Mount
- Contract N00164-04-D-4833 Awarded to Elcan Optical Technologies







# LA-5/PEQ Integrated Small Arms Illuminator OVERVIEW





- Combined Visible/Infrared Pointing & Illuminating Lasers
- Size and Weight Reductions
- Enhanced Performance over SOPMOD Baseline
- 0.5 MOA Adjustments
- System Integrated with Forward Handgrip
- Potential Wireless Remote Capability
- IFF Capable
- Contract N00164-05-D-8510 Awarded to Insight Technology





# SU-233/PVS Visible Bright Light III (VBL III) OVERVIEW





- Increased Luminosity
- Size and Weight Reduction
- Improved Durability
- Based Upon Insight Model M3X
- M6X VBL w/ Integrated Visible Laser Also Available for Spiral Developments
- Contract N00164-05-D-8568 Awarded to Insight Technology





## AN/PVS-24 Night Vision Device OVERVIEW





- Original ORD 5 Block II
- Sized and Scaled for Use on Carbines and Light Machineguns
- Gen III OMNI V Auto-Gated Image Tube
- Potential Sensor Fusion Spiral Development
- Lightweight
- Improved Zero Retention for Day Scopes
- Contract N00164-04-D-4839 Awarded to Litton





## SU-232PAS Thermal Sight OVERVIEW





- New Capability
- Significant Size/Weight Reduction
- Improved Target Detection Capability
- For Use as CNVD or Stand-Alone
- 1X-2X Zoom
- Dual Video Output, VGA and RS 170
- Throw Lever Mount
- Improved OLED for Enhanced Performance
- Potential CNVD-Sensor Fusion Spiral Development
- Contract N00164-04-D-4840 Awarded to Insight Technology



#### **MDNS**





#### **Final Round of Testing Underway**

- Final Source Selection
- Integrated System Test
- Validation of Engineering Changes
- Validation of Hardware on Multiple Weapons







#### **Miniature Day/Night Sight Development**











## Miniature Day/Night Sight (MDNS) Development

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**USSOCOM SOPMOD Deputy Program Manager** 

**NSWC Crane** 

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## Weapon Shot Counter (WSC) Development

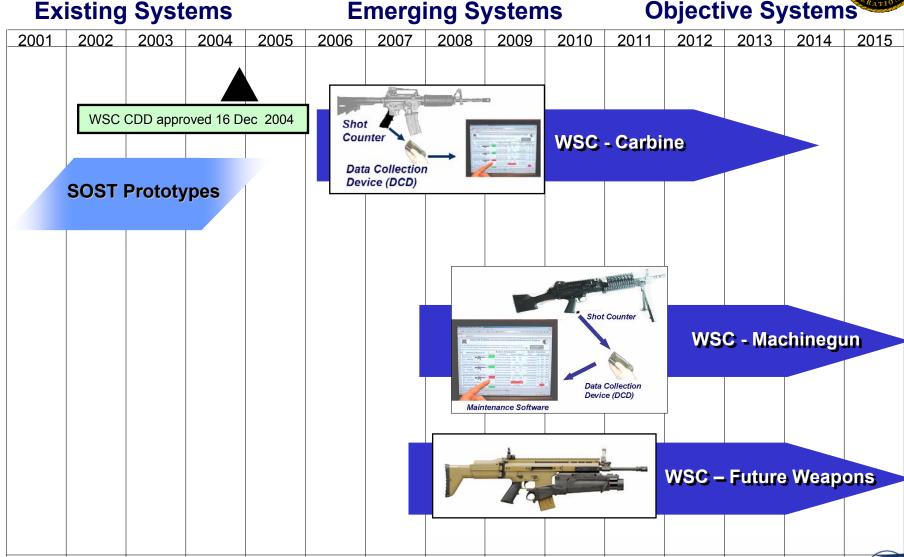




#### **SOPMOD ACQUISTION TOPMAP Weapon Shot Counter Subsystems**

**Unclassified** 

**Objective Systems** 





#### **Weapon Shot Counter (WSC)**

#### DESCRIPTION



#### PERFORMANCE CHARACTERISTICS

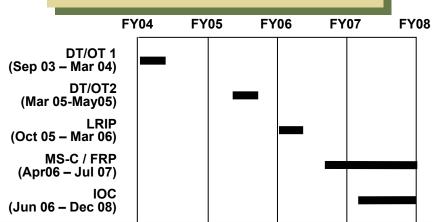
- Sub-Program Status: GREEN
- Enables unit armorers to determine number of rounds fired
- Minimizes catastrophic parts failures and malfunctions in combat
- More cost-effective...reliability, & maintenance

#### APPROXIMATE BUDGET PROFILE

#### Funding On Hand to FY11:

\$0.8M R&D
\$3M Procurement

#### **KEY MILESTONES/ ACTIVITIES**





#### **The Overall Problem**









- If His Gun Fails in Combat, He and His Companions May Die or Lose the Fight
- Worst Failure is a Catastrophic Breakage of Parts That Could Have Been Replaced, such as a Bolt, Leading to a Jammed Weapon That Is Not Repairable During a Firefight
- Second Worse Failure Is a Burned Out Barrel, Making a Hit on His Enemy Unlikely





#### **Bolt Failure Problem**



- Most Bolts Subjected to Harsh Firing Schedules Will Show Initial Cracking Around 3,000 to 6,000 Rounds
- On Milder Schedules, Nearly All Bolts Will Show Initial Cracking at 6,000 to 10,000 Rounds
- Once the Crack Is Initiated, the Bolt May Fail at Any Time, or May Last for Thousands of Rounds, Depending on Crack Propagation







### **Catastrophic Bolt Failure**

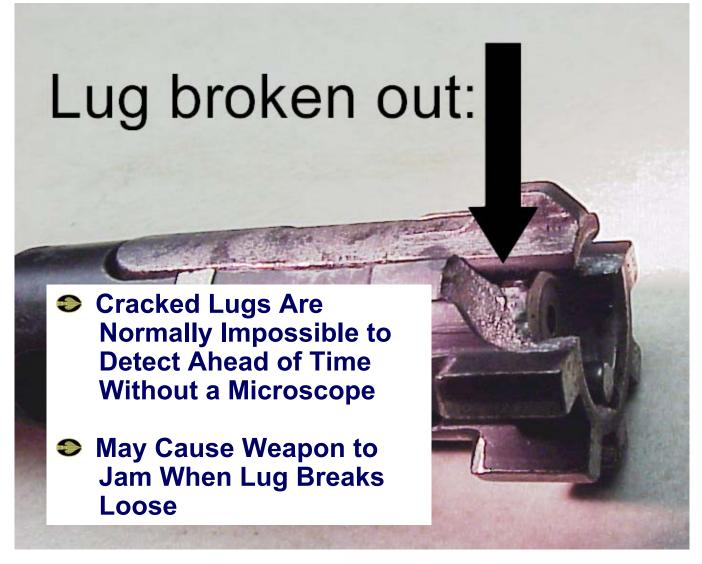






#### **VIEA** Non - Catastrophic Bolt Failure









#### Non - Catastrophic Bolt Failure









#### **The Barrel Burn Problem**



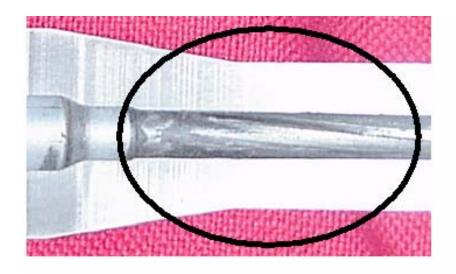
- Most M4A1 Carbine Barrels Subjected to Harsh Firing Schedules Will Be Burned Out Between 4,000 and 6,000 Rounds
- On Milder Firing Schedules, They May Last 10,000 Rounds
- Barrel Gauges Are Only 60% Accurate and Are Expensive to Buy and Calibrate. After Barrel Inspection:
  - The Armorer May Think the Gun Is OK, but There Is a 40% Chance That the Barrel Is Burned Out and the Shooter Cannot Reliably Hit His Enemies
  - The Armorer May Have Turned the Gun in for Depot Overhaul, but There Is a 40% Chance That the Barrel Is Still Good...millions of Dollars Wasted in Unneeded Repairs



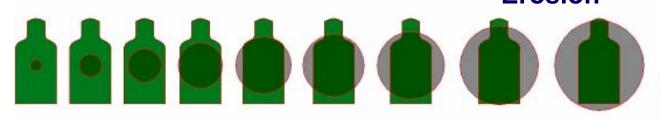


#### The Barrel Burn Problem –Throats





- The Throat Is the Rifled Area in Front of the Chamber
- Erodes Forward of the Chamber in a Cone-shaped Pattern or a Football-shaped Pattern
- Taper Barrel Gauges <u>Do Not</u>
  Adequately Measure Throat
  Erosion

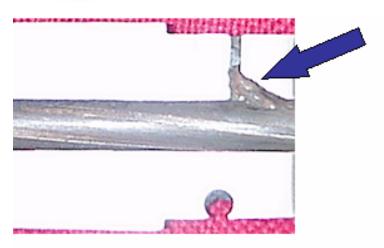


Throat Erosion is the Primary, Progressive Cause of Poor Accuracy



#### **The Barrel Burn Problem – Gas Port Erosion**





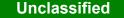
- Unburned Powder Particles Mixed in Hot Gasses Erode Port
- Decreases Gas Friction, but Without Increase of External Port Size
- Cannot Be Detected With Gauges

- Increases Rate of Fire
- Increases Bolt, Spring, and Part Fatigue
- Possible Cause of Failure to Eject and Poor Accuracy



Harnessing the Power of Technology for the Warfighter







#### **Shot Counter Goals**



- Modify the Current Maintenance System From a Time Schedule to a Usage Schedule
- Minimize Catastrophic Failures and Weapon Jamming, and Resultant Injuries or Deaths in Combat





- Enable Weapons Maintenance Personnel (Armorers) to Easily
- Determine the Number of Rounds Fired Through a Weapon
- Provide Data Collection Device (DCD)

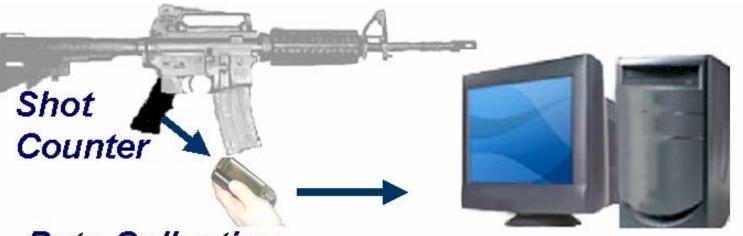






#### **Summary of WSC System**





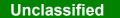
Data Collection Device (DCD)

Load to PC or Laptop



Determine Weapon Status – Conduct Maintenance Actions







#### **Devices**







#### **Potential Spiral Developments**





#### Shot Counters for Other SOF Small Arms





- Distinguish Blanks From Ball Ammo
- Distinguish Between Dry and Live Fire
- Cadence of Fire
- Barrel Temperature











# Weapon Shot Counter (WSC) Development

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<u>Distribution Statement A</u> - Approved for public release; distribution unlimited.





# Weapon Shock Simulation



<u>Distribution Statement A</u> - Approved for public release; distribution unlimited.



## The Challenge





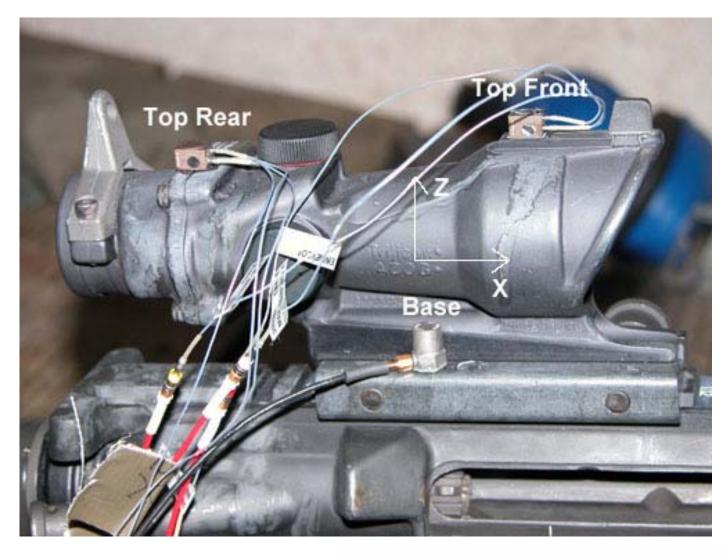
- Development of Accessories for Small Arms
- Example Developmental Test Endurance Requirement
  - Live Fire
    - 30,000 Rounds per unit, 10 units tested
    - ~80 cents per Round (labor + ammo + maintenance)
    - \*\* \$24,000 per unit, \$240K total cost for endurance test





## **Data Acquisition**









## **Data Acquisition**



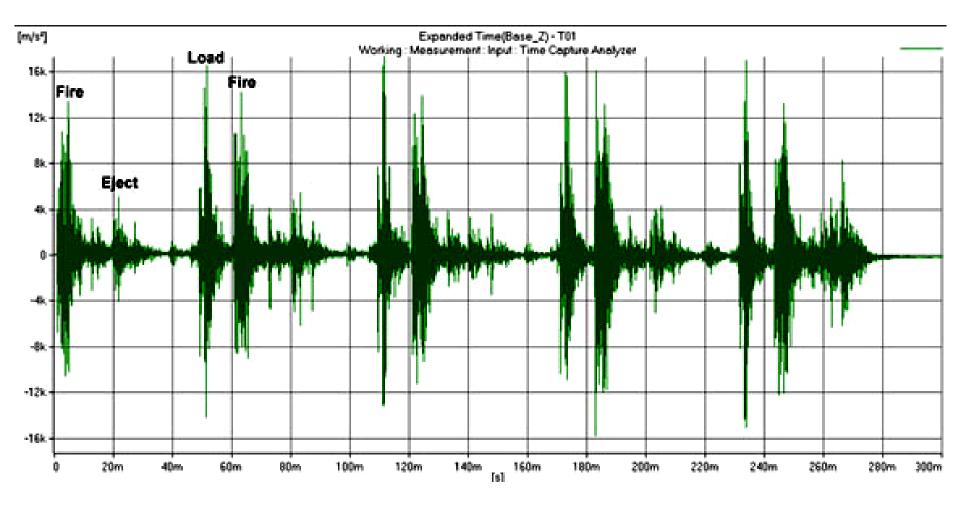






## **Typical Profile**









## **Typical Values**



ACOG Values G/100																
	Top Front X				Top Front Z				Top Rear X			Top Rear Z				
	+ve		-ve		+ve		-ve		+ve		-ve		+ve		-ve	
	low	high	low	high	low	high	low	high	low	high	low	high	low	high	low	high
MK46	5	11	4	9	2.5	6	3	6	4	11	5	10	2.5	5	2	5
M240B	5	11	4	9	3	6.5	3.5	8	6	12	6	20	3	4.5	3	7
M249	6	15	6	14	5	21	4	16	7	14	8	14	2.5	6	4	6
MK48	6	17	6	9	4	6	4.5	9	4	13	4	9	3	8	3	14
M4A1	20	36	24	42	8	16	8	16	8	17	9	20	4	12	6	9



## **Shaker System**





## Previously-Purchased System





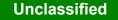








## **Shaker System**





#### **Shaker Specification**

Shaker	TV 5800/LS-330					
Amplifier	A 52318					
Rated Force	16kN (3.6Kip)					
Frequency Range	DC-3kHz					
Displacement	50.8mm (2in)					
Velocity	2.5m/s (100in/s)					
Acceleration	176g					
Moving Mass	9.3kg (20lb)					
All values are shock ratings						

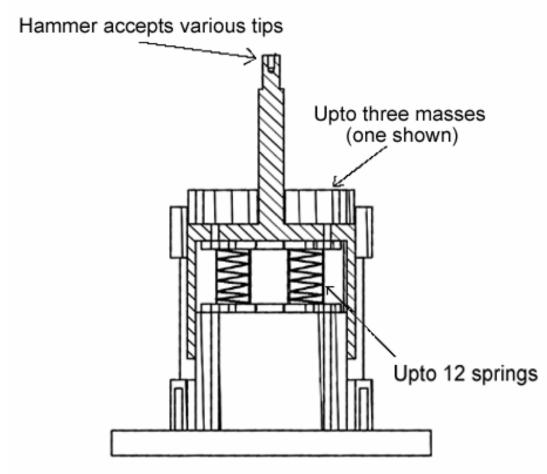




## **Shaker System**



#### **Shock Amplifier**

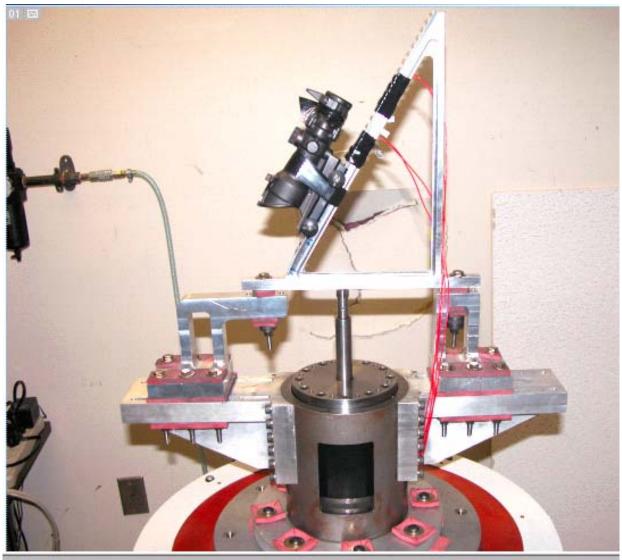






## **Test Setup**



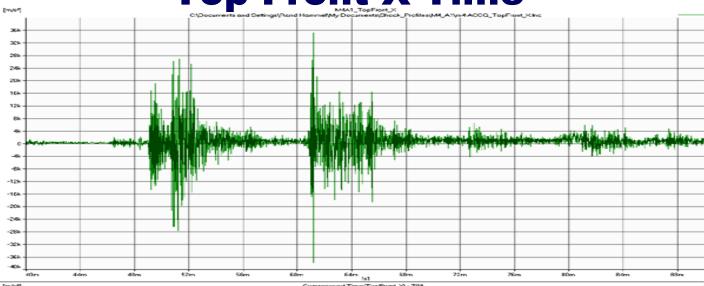


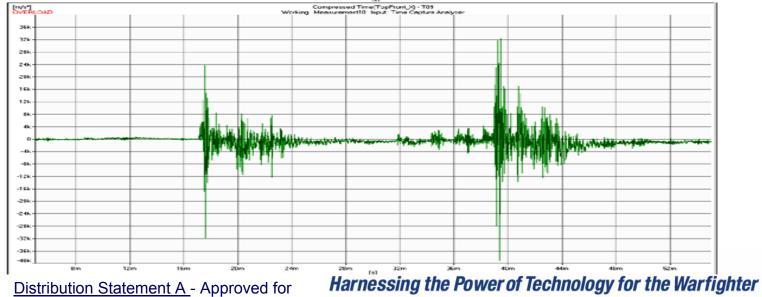






**Top Front X Time** 



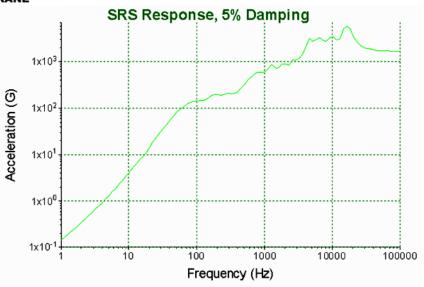




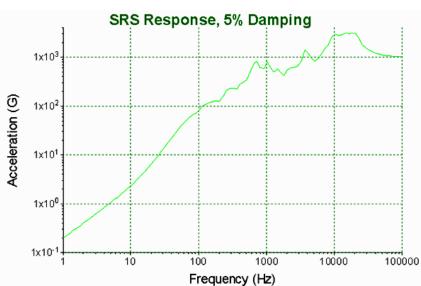








#### **Top Front X SRS**

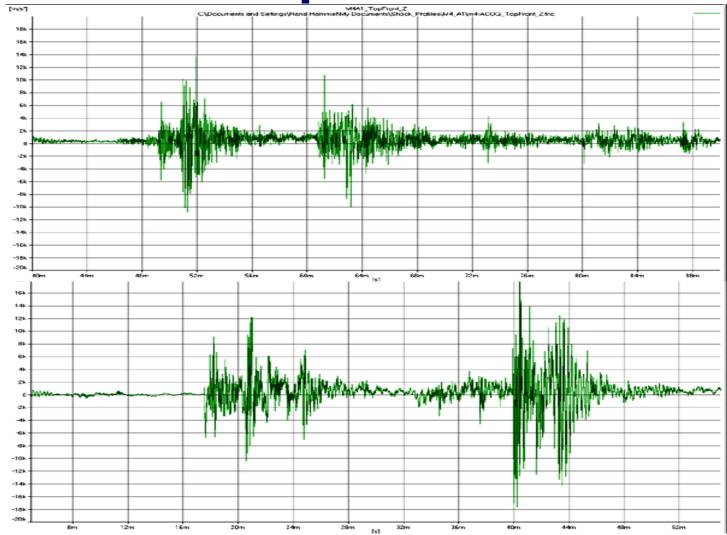








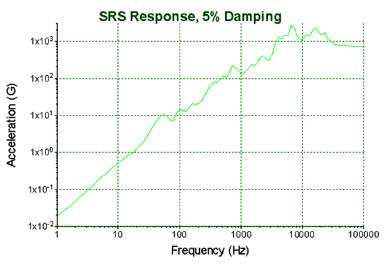
## **Top Front Z**

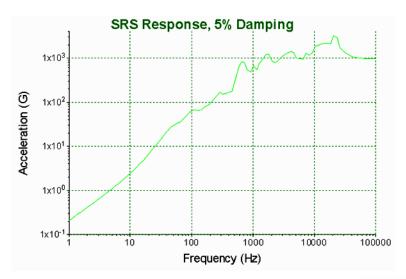












## **Top Front Z SRS**







- Representative Failures Have Been Reproduced On Several Accessories
  - Reticle Failure On Scope
  - **Battery Failures On Several Devices**
  - Accurate Counting Of Shot Counters
  - **Mount Failures On Several Devices**
  - Cable & Connector Failures Of Internal Electronics

Harnessing the Power of Technology for the Warfighter

- Simulation And HALT Testing Catch And Fix Design **Weaknesses Prior To Fielding**
- Need To Continue To Compare Lab And Field Failures
  - **Does Not Completely Replace Live-fire**





#### **Conclusions**



- NSWC Crane developed a shock simulation system that amplifies the impulse of an Electromagnetic Shaker to replicate firing shock profiles on small arms accessories
- Further testing needed to validate simulations through a comparison of field and lab failures
- Current shock simulation capability has demonstrated cost savings and contributed to design improvements







## Weapon Shock Simulation

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# New Initiatives And Business Opportunities





#### Clip-on Night Vision Device - Sensor Fusion





#### CNVD-SF CONCEPT IMAGE

#### **Initial Objectives:**

- Improved Target Acquisition
- Less than 2 Pounds
- Less than \$30K Per Copy, Objective less than \$10K
- Technology Readiness Assessment Complete
- Draft Specification and Acquisition Strategy Published, Open for Public Comment until End of June 2006







#### **Crew-Served and Heavy Weapons Aiming Laser**



- Infrared Laser Capability (and Visible Green Laser?) Out to 2.2 KM
- Weight Less Than 1.5 lbs
- DL123 Battery and External Power
- MIL-STD-1913 Interface
- Compatible with
  - **№** M2 50 Cal MG
  - **→** MK 47 ALGL?
  - **M240 MG (Series)**
  - MK15 .50 Caliber Sniper Rifle
  - MK 44 Mini Gun Sys
  - **MK 48 LMG**
  - MK 19 (and Other Weapons?)
- Specification Published for Comment Open Until 15 June 2006



CSHWAL CONCEPT IMAGE



#### **Crew-Served Visible Bright Light**



- Visible White Light and Infrared Illumination Capability Out to 2.2 KM?
- Weight Less Than 2.5 lbs?
- DL123 Battery and External Power
- MIL-STD-1913 Interface
- Compatible with
  - M2 50 Cal MG
  - MK 44 Minigun System
  - **MK 19?**
  - **MK 47 ALGL?**
- Force Development Experimentation Ongoing
- Market Survey and Performance Specification Being Drafted



CSVBL CONCEPT IMAGE



#### **Weapons Quadrant Mounts**



- Specific Specialized Range-Adjustable Quadrant Mounts for:
  - **→ M2 50 Cal MG**
  - MK 44 Minigun System
  - **MK 19**
  - MK 47 ALGL? (On Separate Announcement)
- Compatible or Able to be Integrated into Current Ballistic Shields – NOTE: Shields Can be Modified
- MIL-STD-1913 rail surfaces to accept various sights
- A Conceptual Objective Sighting Combination would provide Range-Adjustable Quadrant Rails for:
  - Rapid Aiming, e.g. SU-231/PEQ Reflex Sight
  - Night Passive Aiming, e.g. SU-231 + Clip-ons (CNVD's)
  - Night Active Aiming: CSHWAL and CSVBL





#### Miniature Red Dot (MRD)





- Provides Attachable CQB Capability to Existing SOPMOD Sights
- Currently Available in COTS Configuration on Contract N00164-04-D-4834 Awarded to Trijicon
- Needs to be Improved:
  - Needs Durability to Meet All SOF Combat Requirements
  - Waterproof up to 66 Feet
  - Easier Battery Change





#### **Boresight Training Aids**



- BTA will provide small, inexpensive, easily transportable devices that can be quickly installed and removed from the weapon to provide a means of verifying the collimation of the point-of-impact/point-of-aim
- Compatible with SOPMOD Aiming and Target Acquisition Systems and the following weapons:
  - M4A1 Carbine
  - M24 and M82 Sniper Rifles
  - Mk11 Rifle
  - MK12 Special Purpose Rifle (Series)
  - MK13 Series Sniper Rifle
  - M240 MG (Series)
  - M249 MG (Series)
  - Mk46 LMG
  - Mk48 LMG
  - MK16 SCAR Light
  - MK17 SCAR Heavy









#### Flash Hiders





- Product-Improved Attachable Flash Hider to 5.56mm Carbines and Machineguns
- Must be Compatible with SOPMOD Sound Suppressor
- Current Small Purchases for Force Development Test / Experimentation





## SUMMARY: Free World Business Opportunities



- Clip-on Night Vision Device Sensor Fusion
- Crew Served/Heavy Weapons Accessories
  - Crew Served Heavy Weapons Aiming Laser (CSHWAL)
  - Crew Served Visible Bright Light (CSVBL)
  - Weapon Quadrant Mounts (WQMs)
- Miscellaneous
  - Miniature Red-Dot (MRD)
  - Boresight Training Aids (BTA)
  - Sound-Suppressor Compatible Flash Hiders







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#### 2006 Joint Services Small Arms Systems Annual Symposium



# Virtual Wind Tunnel Experiments for Small Caliber Ammunition Aerodynamic Characterization

Paul Weinacht
US Army Research Laboratory
Aberdeen Proving Ground, MD







#### Introduction



- Aerodynamic prediction methodologies and requirements
- The virtual wind tunnel technique
- Recent applications
  - M855 Aero
  - Effect of rifling grooves
  - Effect of base geometry
- Conclusions
- Acknowledgement







#### Aerodynamic Prediction Methods



- Fast-design codes
  - Prodas, AP02 (Navy), Missile DATCOM (Air Force)
  - Semi-empirical techniques
  - Good predictions if design is within the database
  - Static aerodynamics (drag, pitching moment) better than dynamic aerodynamics
  - Some geometric aspects not considered
- Computational fluid dynamics
  - High-fidelity physics
  - More capability for assessing geometric details
  - Complete static/dynamic aerodynamic capability now available







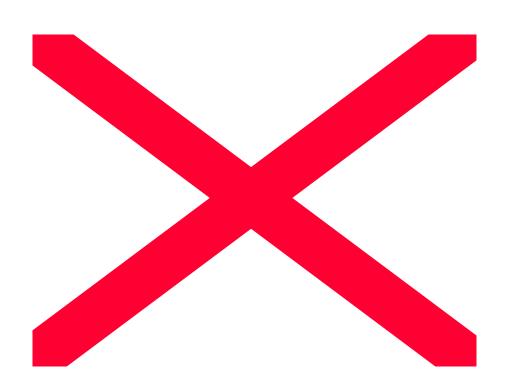
## Requirements for Small Caliber Aerodynamics Analyses



Desired Analysis	Required Aerodynamics	Predictive Capability
Point-mass Trajectory (Gravity drop, velocity decay, wind drift)	Drag vs. Mach number	Steady Aerodynamics (Two-dimensional)
Gyroscopic Stability (Rifle twist rate)	Pitching moment vs. Mach number	Steady Aerodynamics (Three-dimensional)
Dynamic Stability, Trim Angles, 6DoF Trajectory	Full static and dynamic aero; Magnus and pitch-damping moments	Unsteady Aerodynamics









#### **Observations on Free Flight Motion**



- Free flight angular motion is complicated
  - Damped epicycle
  - Time-dependent motion
  - Characteristic frequencies/times
    - Spin rate
    - Fast mode frequency
    - Slow mode frequency
  - First two frequencies driven by rigid body dynamics, not aerodynamics!
- Is it necessary to duplicate this motion to get the aerodynamics?







## Approaches for Determining Aerodynamics



Virtual Fly-Out Technique	Virtual Wind Tunnel Technique
Mimics aeroballistic range tests	Computational analog of wind tunnel
Aerodynamics coupled to rigid body dynamics (RBD)  •Time-scales driven by RBD  •Single time-scale for all aero  •Unsteady/time-dependent flow	Aerodynamics independent of rigid body dynamics (RBD)  •Time-scales driven by aerodynamics  •Multiple time-scales possible  •Steady-flow possible
Full nonlinear coupled aero (CFD) for virtual fly-out, BUT if aerodynamics are extracted from trajectory, aero model required.  •Assumed form for nonlinear effects •Potential coupling between nonlinear Magnus/pitch-damping	Aerodynamics modeled as sum of independent effects; pitch/yaw, pitch/yaw rate, spin, spin/yaw coupling  No assumed/pre-determined form for nonlinear effects  Independence of Magnus and pitch-damping

Virtual Wind Tunnel technique should be more efficient and provide better aerodynamics!

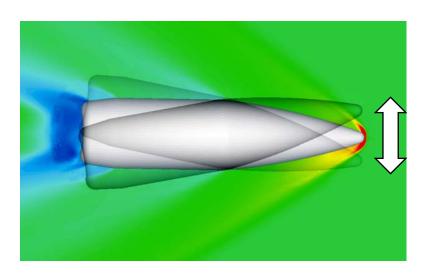


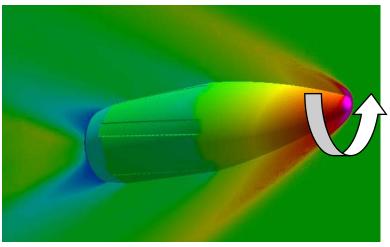




#### The Two Virtual Wind Tunnel Experiments







The Pitch-Damping Experiment

**The Magnus Experiment** 

- All required aerodynamics needed to predict stability, performance and free-flight motion can be obtained from these two experiments.
- Key feature: Independent determination of pitch-damping and Magnus – eliminates coupling found in aeroballistics range experiments.



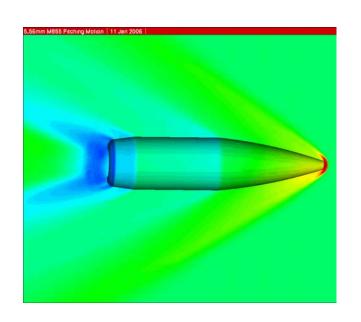


#### Pitch-Damping Experiment



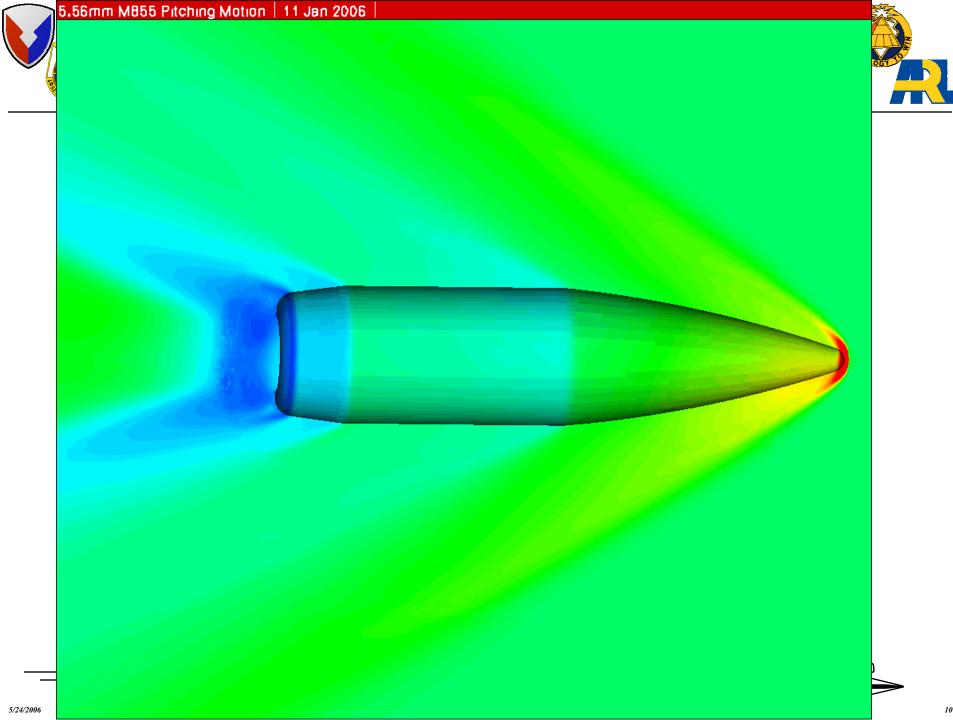
- Two approaches possible
- Planar constant amplitude pitching motion (unsteady flow – nonaxisymmetric geometries)

- Coning motion (steady flow rotationally symmetric geometries)
- Predicted Aerodynamics
  - Pitch-damping force and moment
  - Static Aerodynamics (lift, drag, pitching moment)







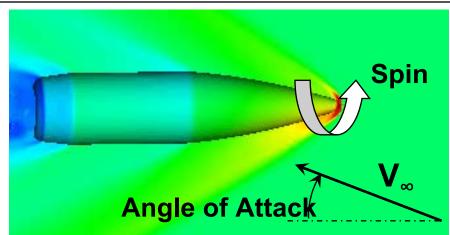




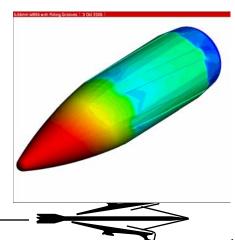
#### Magnus Experiment



- Constant angle of attack, constant spin rate
- Steady flow for axisymmetric bodies, unsteady flow otherwise

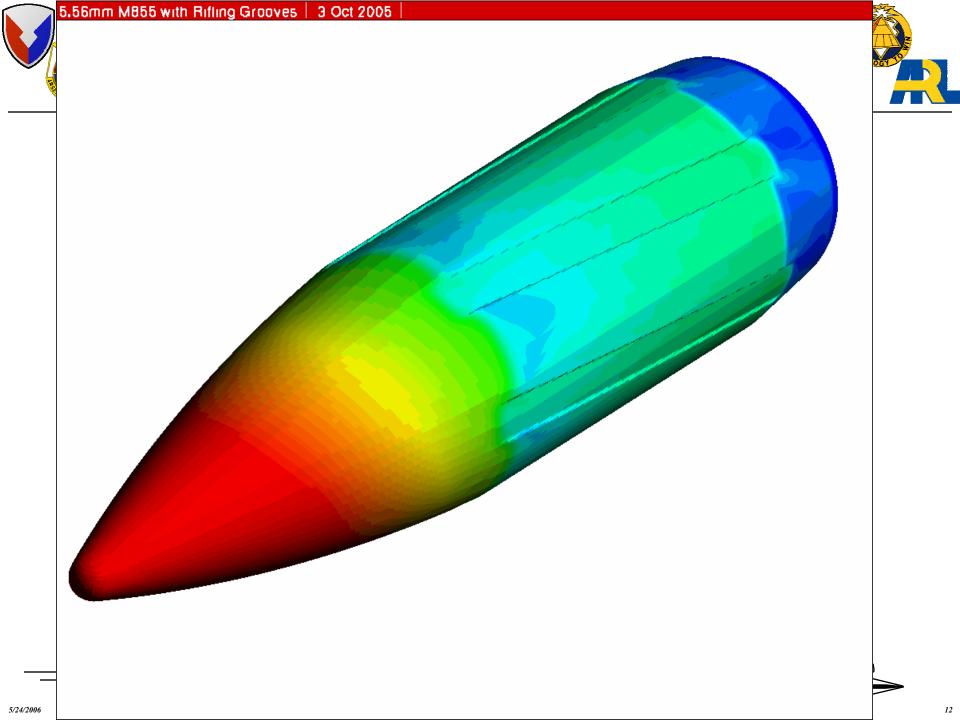


- Predicted Aerodynamics
  - Magnus force and moment (Cross-coupling between angle of attack and spin)
  - Roll damping
  - Static Aerodynamics (lift, drag, pitching moment)











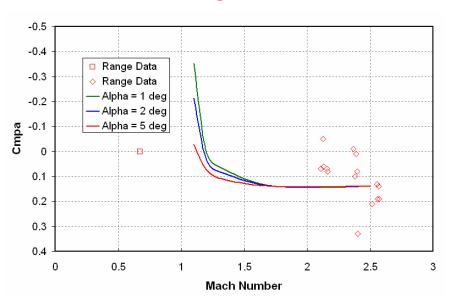
#### Aerodynamic Predictions for 5.56mm M855



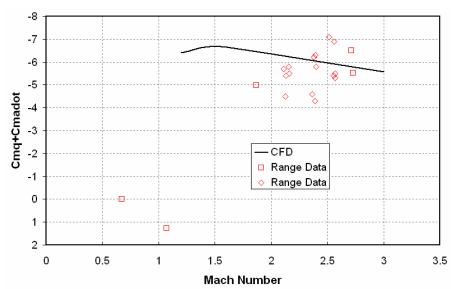
#### Significance/Purpose:

- Virtual wind tunnel approach applied to M855.
- Currently supporting Army Green Ammo development efforts using this methodology.

#### **Nonlinear Magnus Moment**



#### **Pitch-Damping Moment Coefficient**





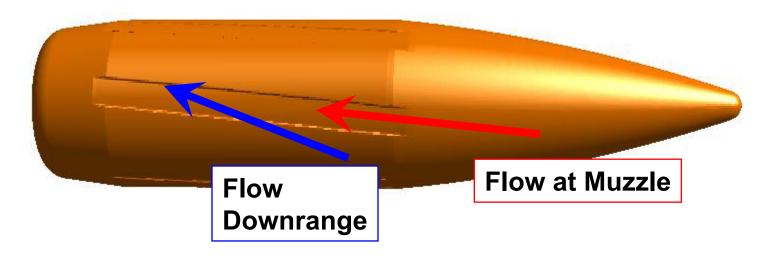




#### Rifling Groove Effect



- At muzzle flow aligned with grooves
- Downrange projectile velocity slows faster than spin rate
  - Projectile is "overspun"
  - Effects spin-sensitive Magnus moment



An important focus: effect of engraving on aerodynamics

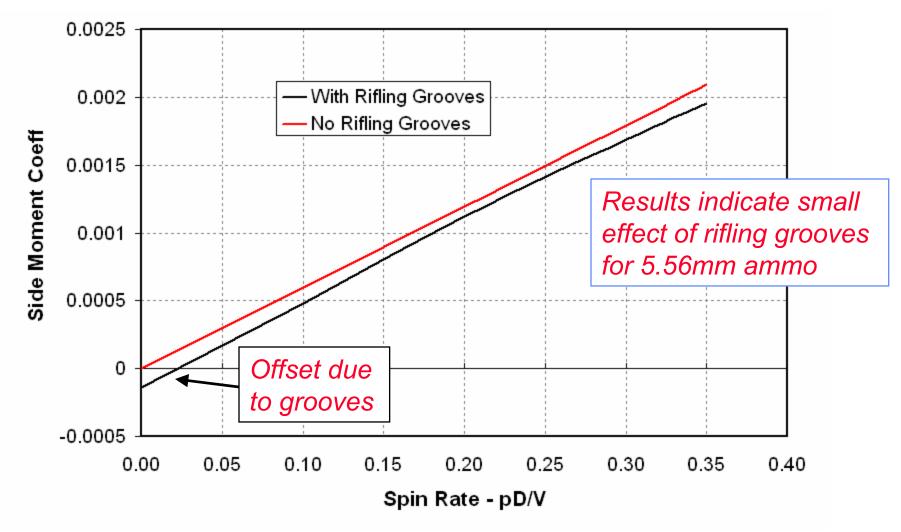






#### Effect of Grooves on Magnus Moment





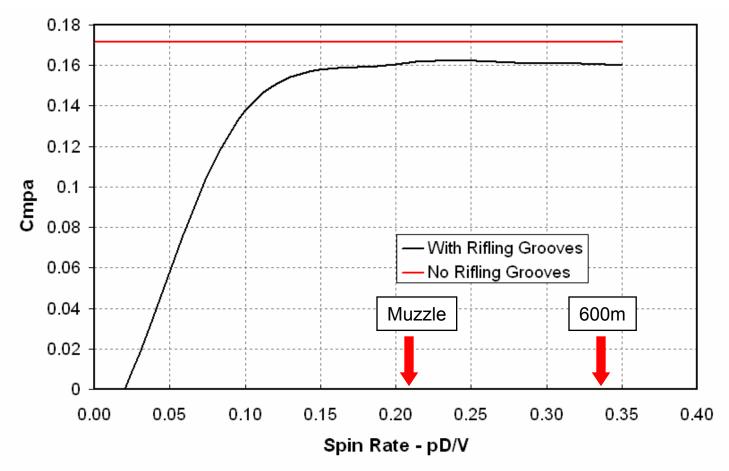






### Effect of Grooves on "Effective" Magnus Moment Coefficient





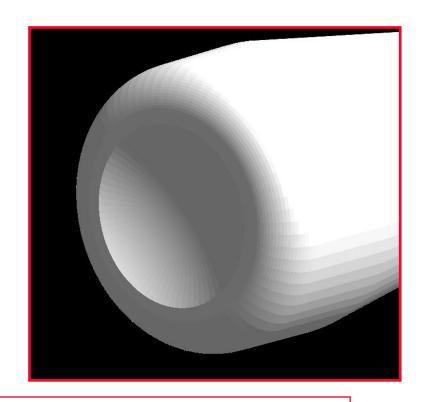
For 5.56mm ammo, slight offset in side moment affects Magnus moment only at low spin rates. Demonstrates that special twist rate guns (match spin) <u>not</u> required for aeroballistic testing!



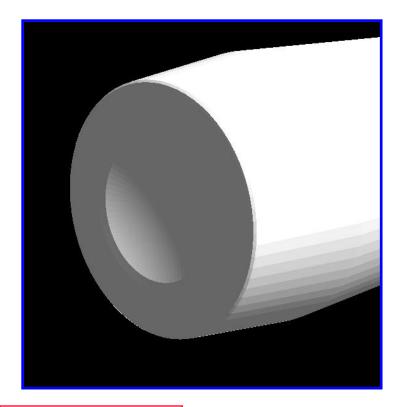


## Effect of Base Geometry on Magnus Moment/Trim Angles





**Traditional Rounded Base** 



**Square Base** 

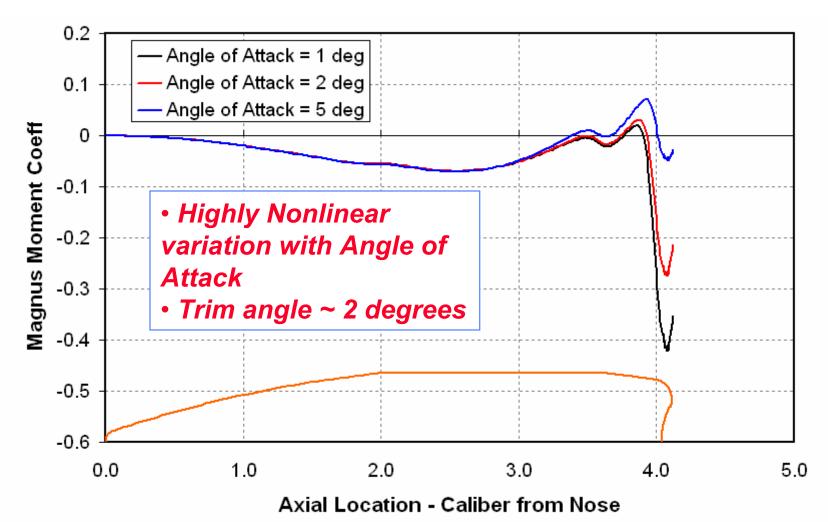






## Magnus Moment Distribution Along Body - Round Base





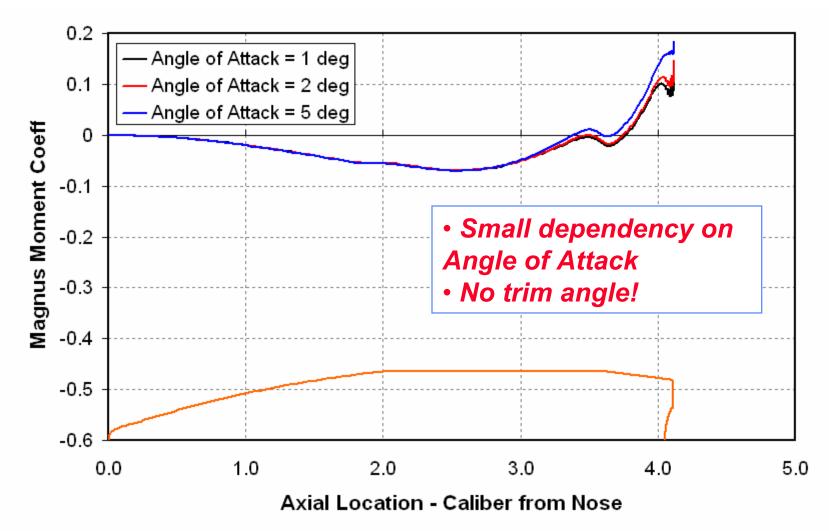






#### Magnus Moment Distribution Along Body - Square Base











#### **Conclusions**



- A fast and efficient methodology for aerodynamic prediction developed for small caliber ammo
- Method is easily extended to medium/large cal
- Technique has been used to advance understanding of small caliber aeroballistics
  - Rifling grooves
  - Base geometry
- Currently using approach within Green Ammo Program

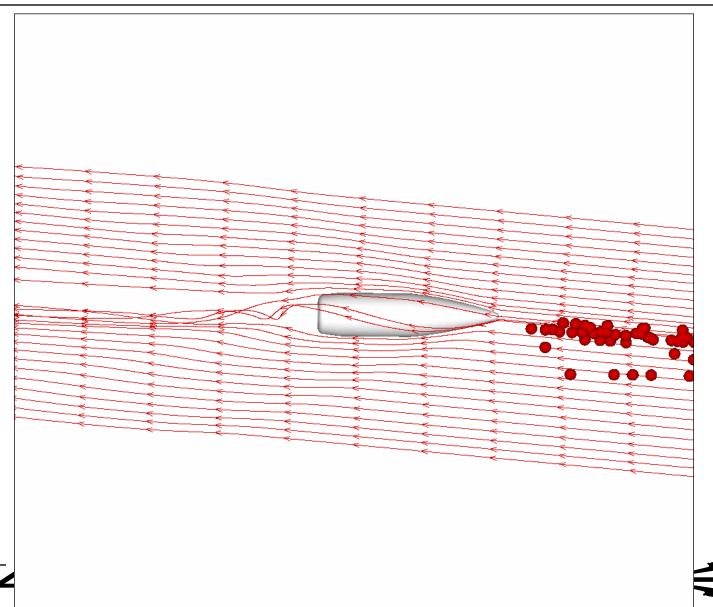






#### Acknowledgement









## Experimental Characterization and Modeling of 5.56-mm Ammunition

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Presented at NDIA Joint Services Small Arms Systems Annual Symposium

May 17, 2006 Albuquerque, NM



#### Motivation



- Objective develop state-of-the-art physics based interior ballistics (IB) predictive capability for small-caliber ammunition
- Leverage IB knowledge gained from large-caliber arena
  - ARL-NGEN IB modeling capability in-hand (primer model not available)
  - Develop detailed primer (Primer No. 41) model to be coupled w/ NGEN code
- Capability enables:
  - Better understanding of current ammunition
  - Analysis of variations in performance
  - Optimization of components (primer, propellant, etc)
  - Comparison of alternative primers

PMMAS Funded Effort



#### Status



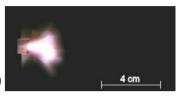
- Initial phase of experimental primer and ignition system studies complete
- Initial results with ARL-NGEN code/gas only primer available
- Primer model developed and being validated
- Coupling new primer model with ARL-NGEN code in progress



## No. 41 Primer: Open-Air Studies



- High speed digital video (38000+ fps)
  - → Particle size and velocity
  - → Relative brisance





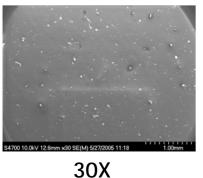


Time = 540  $\mu$ s

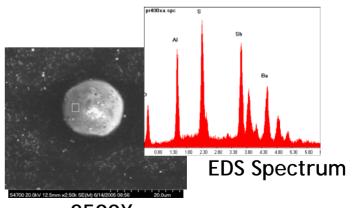
- Witness plate studies
  - → Particle composition and size distribution







( 1100X



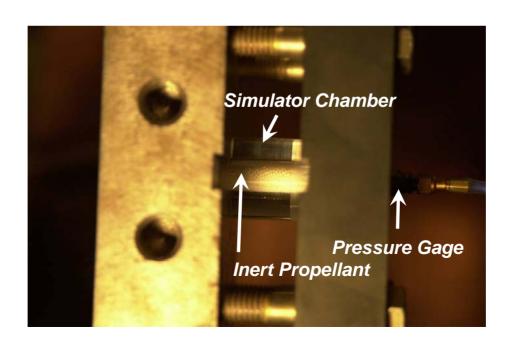
2500X

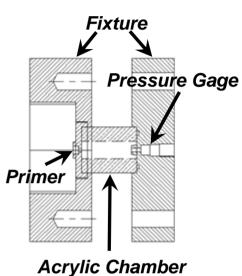


### 5.56-mm Ballistic Simulator - setup



- Simulates 5.56-mm chamber volume and geometry
- Transparent chamber allows for visualization of primer output (flamespreading)
- Measure pressure-time response

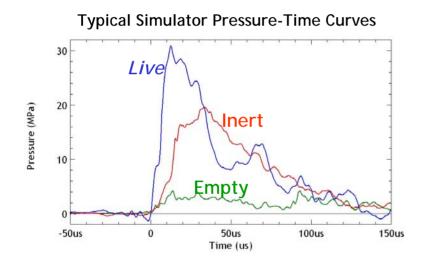




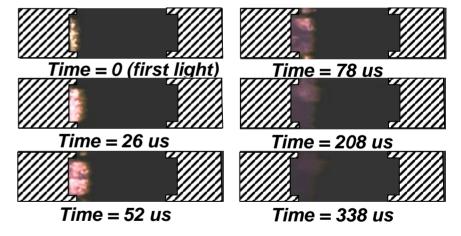


### **Typical Simulator Results**





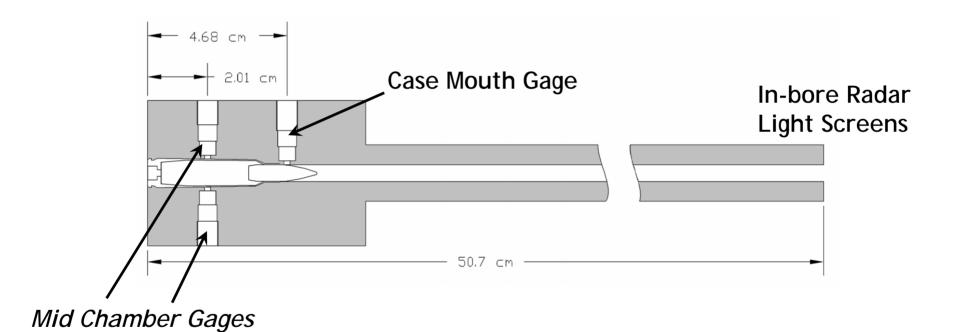
Typical Flamespreading for Live Propellant Simulator





### **Gun Tests**

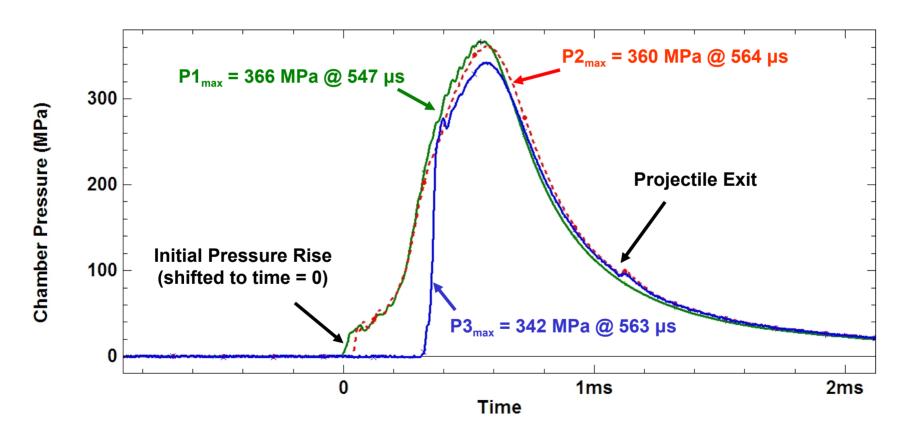






### **Gun Pressure Data (Test 065)**

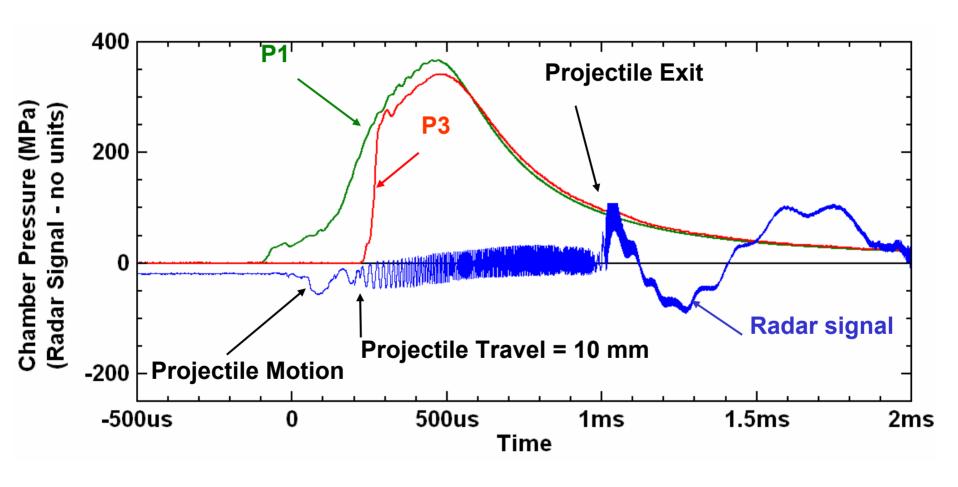






### Pressure and Radar Data (Test 065)







## Modeling motivation

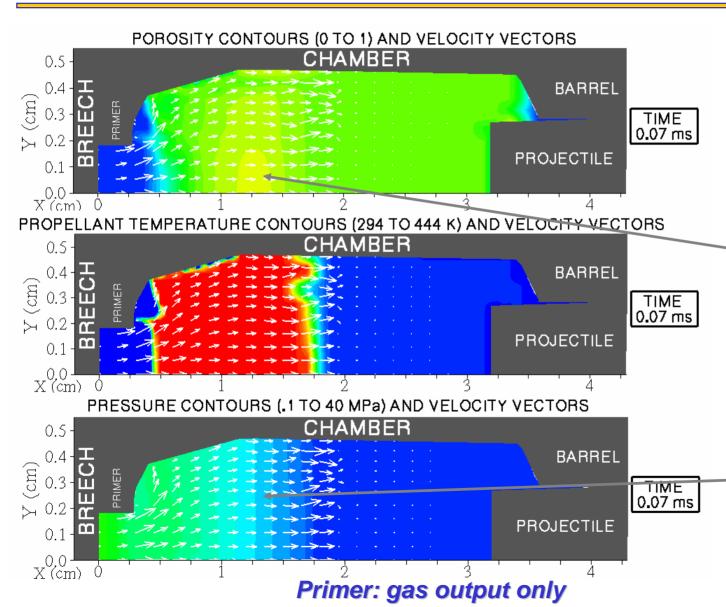


- Experiments show that particles are released into the gun chamber by the igniter in a random manner. (Williams et al. 2005)
- IB models treat primers, flash tubes, and igniter tubes as look-up tables made up entirely of hot gases.
- Hot particles contribute to propellant ignition.
- With multidimensional, multiphase IB codes (NGEN) a two-phase stochastic primer model is an important step forward.



# ARL-NGEN IB Code Simulation of Ignition and Flamespreading in 5.56 Ammunition





These <u>snapshots</u> of the conditions within the ammunition case are at 0.07 ms from primer function (50% to cutoff).

The map of <u>porosity</u> shows movement of propellant from primer face & some compaction of propellant in the case.

The map of <u>propellant</u> temperature shows ignited propellant (red color) and 50% bed flamespreading.

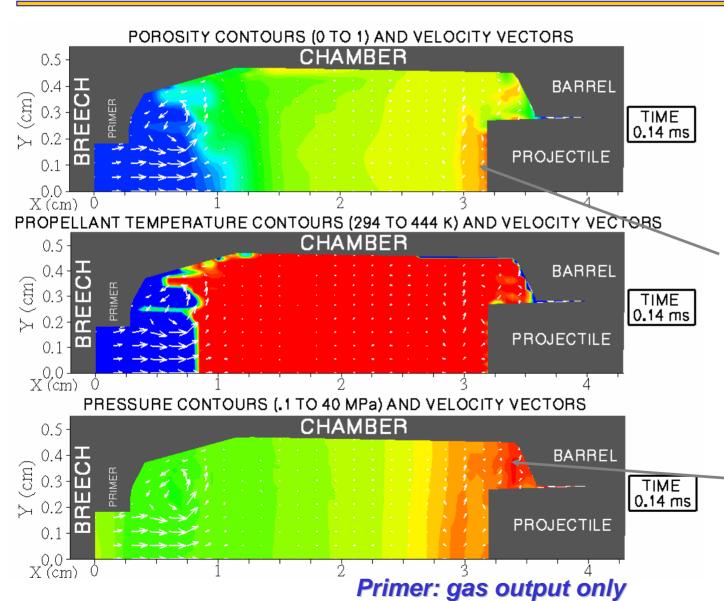
The map of gas pressure contours shows 2D gas flow near the primer and a nearly 1D pressure wave in the case.

Note: Each figure enlarged by 8x in the radial direction for clarity.



# ARL-NGEN IB Code Simulation of Ignition and Flamespreading in 5.56 Ammunition





These <u>snapshots</u> of the conditions within the ammunition case are at 0.14 ms from primer function (near cutoff).

The map of <u>porosity</u> shows movement of propellant from primer face and significant compaction of propellant against the projectile.

The map of <u>propellant</u> temperature shows ignited propellant (red color) and full bed flamespreading.

The map of gas pressure contours shows the occurence of negative  $\Delta P$ .

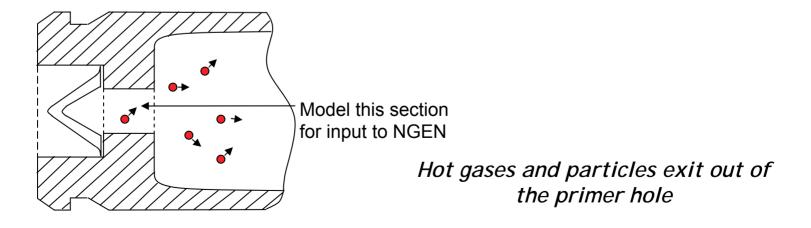
Note: Each figure enlarged by 8x in the radial direction for clarity.



### **Primer Output and Modeling**



- Particles are being transported (whipped around) in primer tube primarily by hot, turbulent gas flow.
- Desire to accurately model gas and particle generation at junction with chamber.
- Primer output is fed into NGEN which transports igniter particles into main gun charge for ignition modeling.





## Summary



- Experimental characterization provides insight into current No. 41 primer performance in 5.56-mm ammunition
  - → primer output
  - → flamespreading
  - → pressure-time-velocity history
  - → propellant bed compaction
- State-of-the-art primer model incorporating gas and particle flow developed and poised for coupling with ARL-NGEN code
- Multi-phase primer model is utilizing some experimental results for validation
- ARL-NGEN code with gas only primer is consistent with experimental results

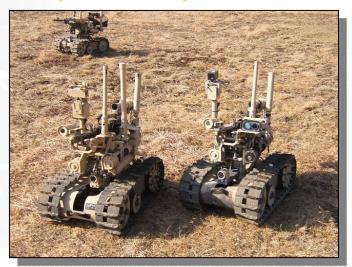


# SWORDS



# Special Weapons Observation Remote reconnaissance Direct action System (SWORDS)





NDIA Joint Services Small Arms Systems Annual Symposium 16-18 May 2006 SWORDS Live Fire Demo on 18 May 2006

#### **Charlie Dean**

Program Manager for Advanced Robots Foster-Miller, Inc

Michael A. Zecca

**SWORDS ARDEC Project Officer, Picatinny Arsenal** 





### **Outline**



- SWORDS Origin
- SWORDS Description
- Operational Scenarios
- Test Requirements & Results
- User Assessment
- Safety Modifications
- \* Conclusion







## The Future is Now





- The GWOT has accelerated the introduction of thousands of new technologies onto the battlefield.
- Small, medium, and large ground and air robots have become common place tools.
- The arming of ground robots is now taking place...





# **The Origin of SWORDS**





Under partnerships with TACOM-ARDEC and TACOM-TARDEC, Foster-Miller integrated Precision Remote's TRAP system onto the Talon 3B chassis, making the first Special Weapons Observation Remote reconnaissance Direct action System (SWORDS)





# **SWORDS Components**



### **\* TALON IIIB**

- 7 ft/sec (~5mph)
- · Talon 33.5 l x 22.5 w x 11 h
- 36 VDC Power System
- 75 lbs w/o payload
- ~ 500 TALON's in Iraq and Afghanistan
- TALON IV (MTRS) in combat today

### TRAP Payload Mount with Cameras

- +/- 30° Azimuth, +30°/-15° Elevation
- · 23 33 lbs
- Can hold multiple weapon systems.
- 7.62x51 6 Lbs per 100 rounds









# **Gunner in the Loop**



- SWORDS Gunner utilizes modified TALON OCU for target engagement.
- The OCU has added fire control features to ensure <u>positively</u> safe weapon operations.
- The Gunner uses the night vision cameras and IR lights for driving and firing during limited visibility operations.



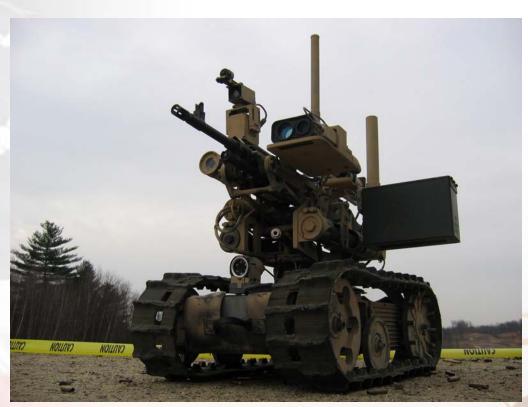




# **Lightweight Fighter**



- SWORDS utilizes the small unit's weapons, allowing integration of the M249 or M240B Machine Guns.
- Currently, the SWORDS utilizes the existing weapon belted ammunition and can quickly be rearmed by all friendly units.
- The SWORDS can be lifted by two men and easily carried in the back of HMMWVs and even on the back of ATVs.







## **Firepower**



- SWORDS permits the gunner to fire in either the automatic mode or the <u>single shot mode</u>.
- The robot platform provides a very steady rest for mounted weapons, thus allowing <u>very</u> accurate fire.
- SWORDS' low profile and dash speed make it a potent weapon for protecting our ground forces while surgically attacking the enemy.







## **Operational Scenarios**



SWORDS acts as a force multiplier for the small unit, allowing the remote positioning of a weapon system that can:

- Provide overwatch
- Conduct recon
- Provide security
- Engage hostile forces

While reducing the exposure of ground forces.



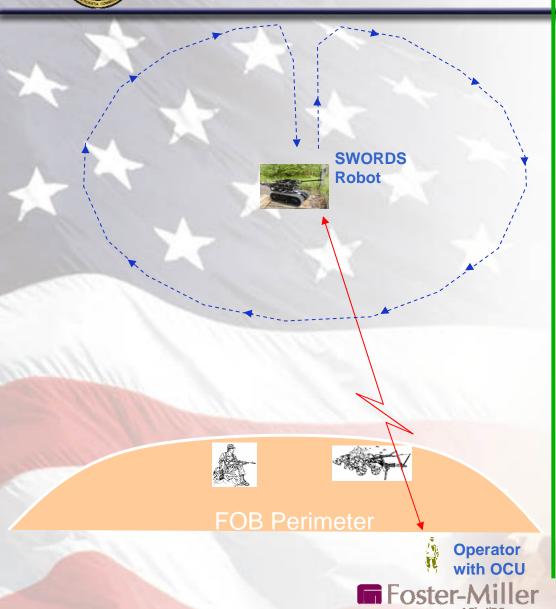






## **Perimeter Security**





#### **Scenario Description:**

- Primary Role is early detection/ warning of enemy activity
- Has ability to engage enemy targets if necessary (M249/M240 MG)
- Deployed forward of friendly perimeter
- Monitors portion of the perimeter
- Performs a roving patrol every few hours
- ➤ Mission length is 2-8 hours
- Operator w/ OCU will be located several hundred meters from the robot LP/OP position
- Max range of robot from operator 200-800M
- Operator will normally have line of sight view of robot



# Reconnaissance & Surveillance





**Operator with OCU** 

(mounted or dismounted)

#### **Scenario Description:**

- Primary Role is early detection/ warning of enemy activity
- Supports dismounted R&S operations
- Can engage enemy targets if necessary (M249/M240 MG)
- Operator and OCU are located within several hundred meters of robot
- Operator maintains line of sight with robot through alley ways/roads
- Expected mission duration is 2-4 hours



# **SWORDS In Action**







### Search & Seizure





**Operator with OCU** 

(mounted or dismounted)

#### **Scenario Description:**

- Primary Role is room clearing/early warning during cordon & seizure type operations
- Robot can destroy hostile personnel
- Operator and OCU are located within several hundred meters of the robot
- Robot only has capability to search ground level floors
- > Expected mission duration is 2-4 hours



# **SWORDS ONS Requirements**



# Operational Needs Statement (ONS) System Characteristics

- SWORDS weapon system options include:
   M249, M240, M107, M203, 12 gauge shotgun, AT-4,and SMAW
  - SWORDS Spiral 1 will mount the M249
    - Follow-on safety testing will include the M240
- SWORDS is operated by a single Soldier with remote computer unit from up to 1,000 meters
  - SWORDS Spiral 1 will operate up to 400-800 meters LOS; 100-200 meters NLOS
  - SWORDS Spiral 1 will carry 5.56/7.62mm ammunition, weigh approximately 200 pounds, battery life of 2-4 hours, and max speed of 2-5 MPH

### **Operational Concept**

SWORDS Spiral 1 will be used to find, fix, and finish the enemy





# **ATC Test Requirements & Results**



#### **Urgent Materiel Release (UMR) Test Requirements & Results**

#### Environmental

- · Cold (+20F) Passed
- · Hot (+150F/160F Solar) Passed
- Rain (Driving issues at the start) (Lens shields improved driving)
- Fording (6") Passed
- Sand/Dust Passed (Minor dust intrusion in TRAP wiring)
- Vibration Passed accelerated profile (400 hours total)
- Drop Passed 3Ft drop with only minor damage

#### \* EMI

- · Several susceptibility issues with video screen loss and RF interference
- No Safety issues at ATC or YTC tests

#### Reliability/Maintainability/Supportability

- Reliability 300 hrs required
  - #3 584 hours
    - #4 527 hours
- TM verification
  - Conducted during the OA. Changes will be incorporated prior to UMR approval.
- Battery performance
  - Met spec requirements

#### Command & Control

- Determine maximum LOS and NLOS
  - Exceeded spec requirement







# ATC Test Requirements & Results



#### Weapon Performance

- Operator issues with boresighting, target acquisition and tracking
  - Follow-on training corrected the deficiencies

#### \* Accuracy

- Lack of target range information to the operator was a limitation
  - Future upgrade will integrate a laser rangefinder

#### Software Safety

- System and unit level testing successful
- Longitudinal & Side Slopes
  - Successful up to 40% Longitudinal and 20% Side Slope
- Steering and Handling
  - Met spec requirement
- Acceleration
  - Met spec requirement
- Obstacles
  - Met most spec requirements







### **User Assessment**



An Operational Assessment (OA) was conducted

by Soldiers and included:

- Live Fire
- MOUT (day and night)
- Perimeter Defense
- Cordon & Search
- Reconnaissance
- Checkpoint
- SWORDS engagement with an OPFOR (MILES)









# **Safety Modifications**



- ARDEC requested the following changes in the area of safety
  - · Fire-on-the-move disabled
    - SWORDS has a non-stabilized weapon mount
  - Firing Command modified
    - Operator aware of degraded communications
    - Proper sequence must be followed to ARM and Fire weapon
  - Kill Switch incorporated
    - Operator control to power down the platform at ranges beyond tactical capability

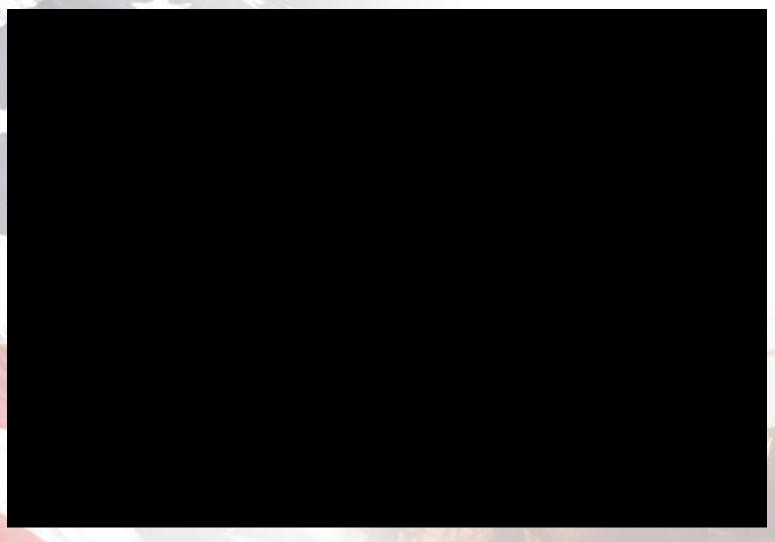






# **Test Video**









### Conclusion



Weaponized unmanned ground vehicles will soon multiply the reach of the Soldier while minimizing the Soldier's exposure to hostile fire

Combat units will begin receiving SWORDS this summer

**SWORDS** will be profiled on The Discovery Channel episode

"Future Weapons" on 17 May 2006

